US009235334B2

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Geis et al.

(10) **Patent No.: US 9,235,334 B2**
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(54) **MANAGING LANDBASES AND MACHINE OPERATIONS PERFORMED THEREON**

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(51) **Int. Cl.**

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G06F 3/0484	(2013.01)
G06Q 10/06	(2012.01)
G06Q 50/02	(2012.01)
G06F 3/0488	(2013.01)

(52) **U.S. Cl.**

CPC ***G06F 3/04842*** (2013.01); ***G06F 3/0488*** (2013.01); ***G06Q 10/06*** (2013.01); ***G06Q 50/02*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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Primary Examiner — David H Chu

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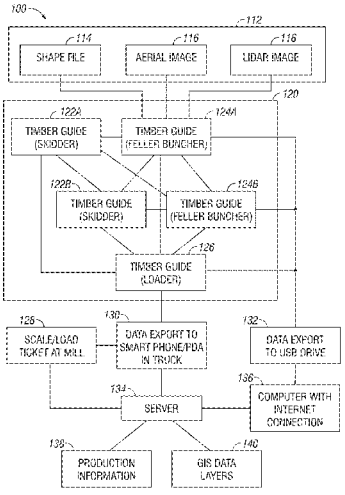
(57) **ABSTRACT**

A method for management of a land base includes interfacing a machine or equipment to a computer running a geographical information system (GIS) application such that the computer is configured to monitor the operations performed by the equipment or machine on the land base and store the operations as map points, lines, or polygons on at least one data layer within the GIS application. The method further includes displaying the GIS application to the operator at the point and time of performing the operations.

27 Claims, 21 Drawing Sheets



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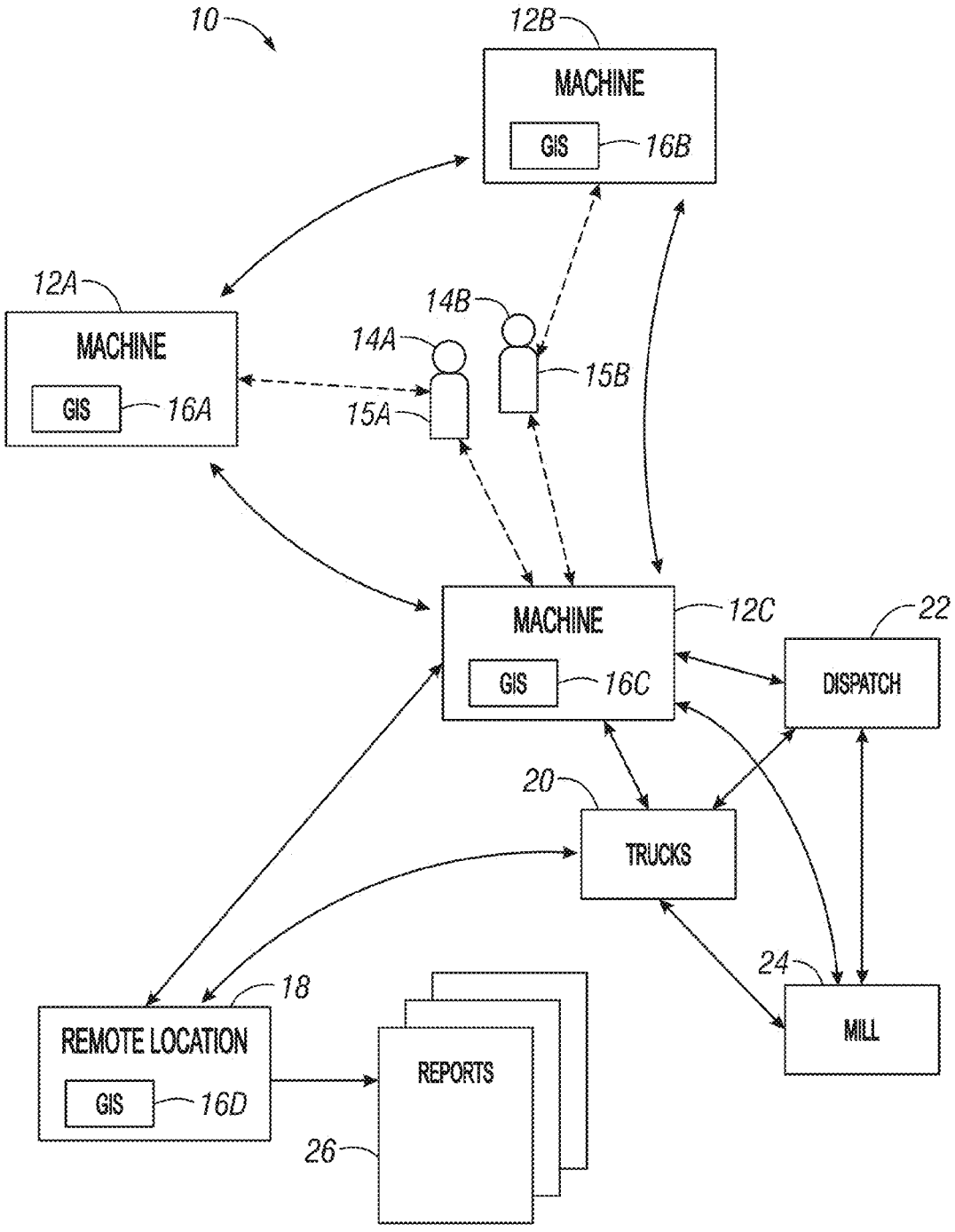
10
12B
MACHINE
GIS
16B
12A
MACHINE
GIS
16A
14B
14A
15A
15B
MACHINE
GIS
16C
12C
22
DISPATCH
20
TRUCKS
24
MILL
18
REMOTE LOCATION
GIS
16D
REPORTS
26

FIG. 1

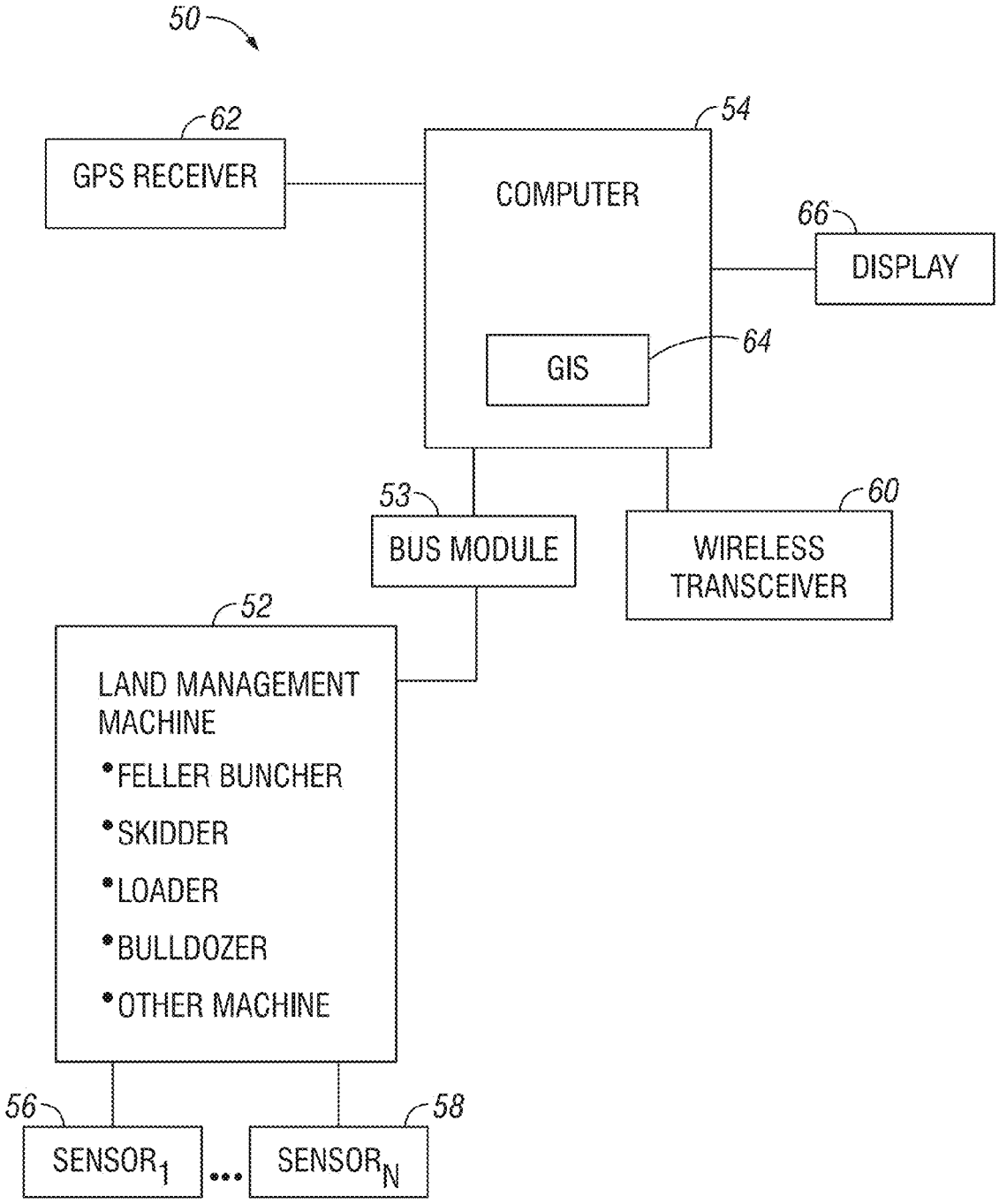
50
62
GPS RECEIVER
54
COMPUTER
66
DISPLAY
64
GIS
53
BUS MODULE
60
WIRELESS TRANSCEIVER
52
LAND MANAGEMENT MACHINE
•FELLER BUNCHER
•SKIDDER
•LOADER
•BULLDOZER
•OTHER MACHINE
56
58
SENSOR1
SENSORN

FIG. 2

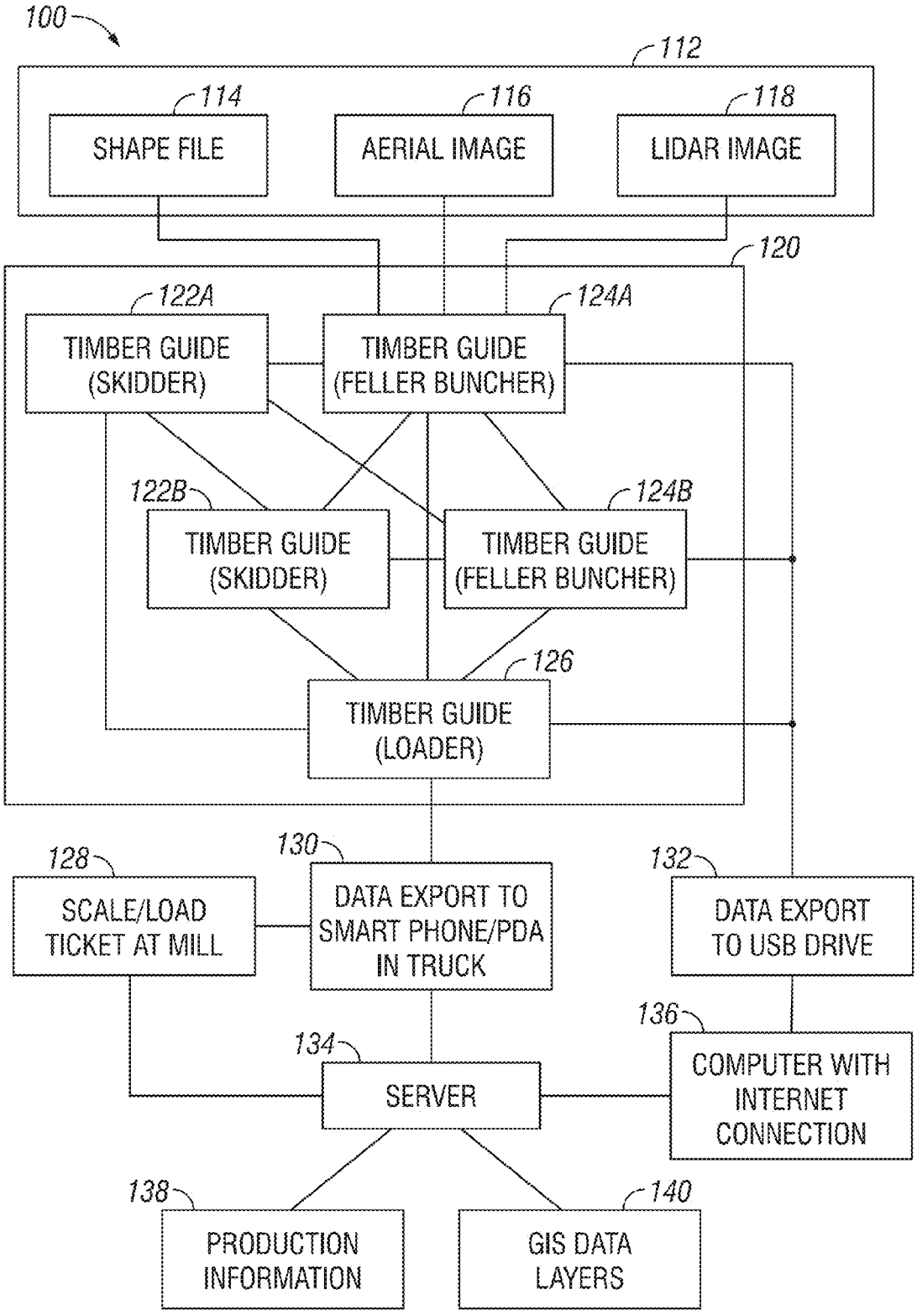
100
112
114
SHAPE FILE
116
AERIAL IMAGE
118
LIDAR IMAGE
120
122A
TIMBER GUIDE (SKIDDER)
124A
TIMBER GUIDE (FELLER BUNCHER)
122B
TIMBER GUIDE (SKIDDER)
124B
TIMBER GUIDE (FELLER BUNCHER)
126
TIMBER GUIDE (LOADER)
128
SCALE/LOAD TICKET AT MILL
130
DATA EXPORT TO SMART PHONE/PDA IN TRUCK
132
DATA EXPORT TO USB DRIVE
134
SERVER
136
COMPUTER WITH INTERNET CONNECTION
138
PRODUCTION INFORMATION
140
GIS DATA LAYERS

FIG. 3

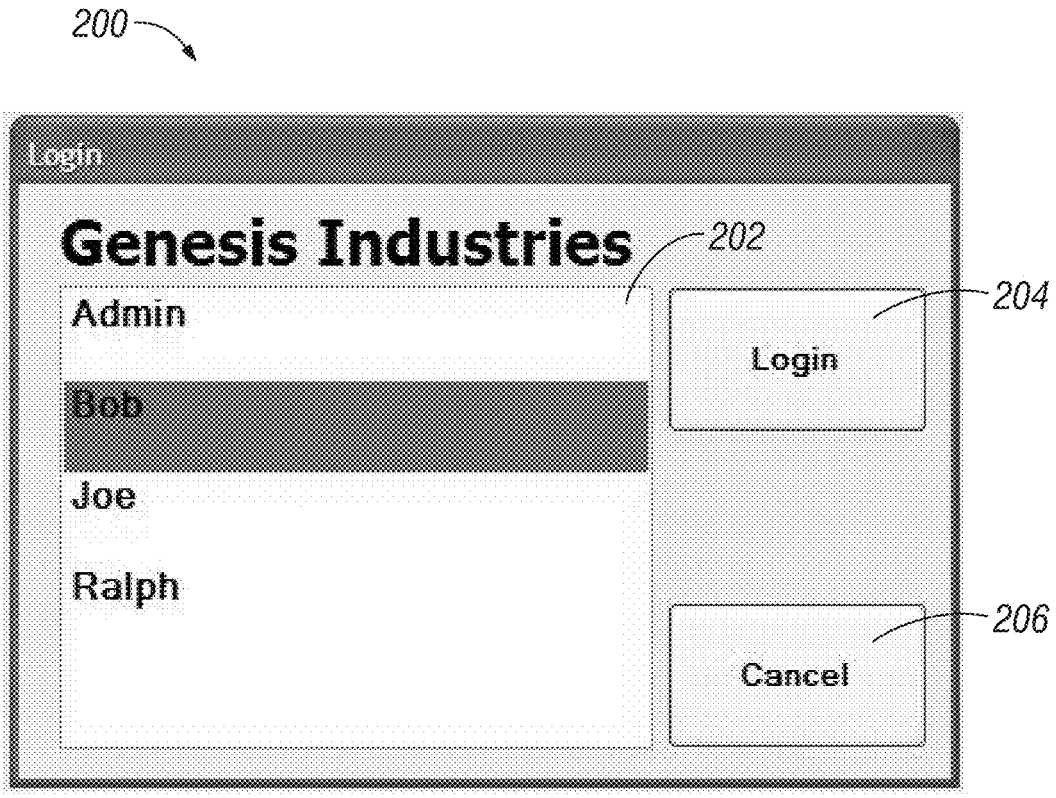
200
Login
Genesis Industries
202
Admin
Bob
Joe
Ralph
Login
204
Cancel
206

FIG. 4

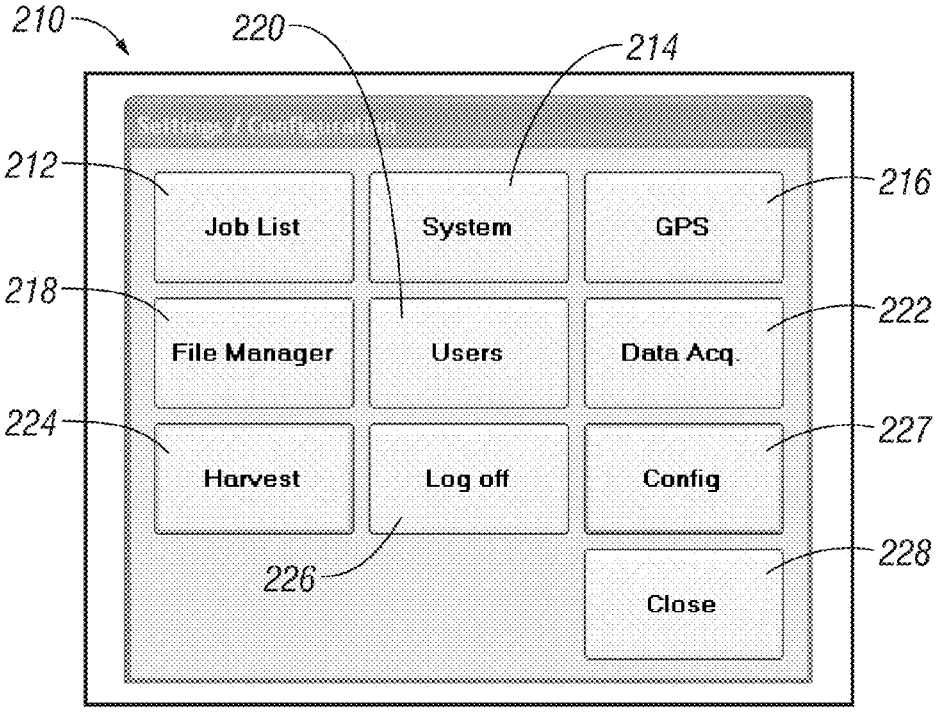
210
220
214
212
216
Job List
System
GPS
218
222
File Manager
Users
Data Acq.
224
227
Harvest
Log off
Config
226
228
Close

FIG. 5A

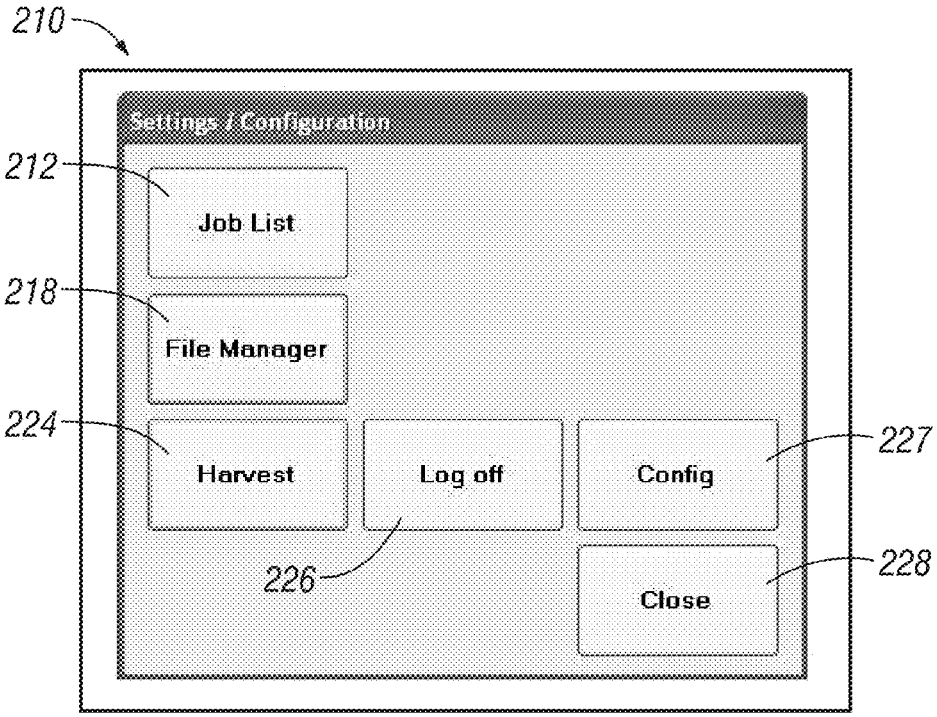
210
Settings / Configuration
212
Job List
218
File Manager
224
227
Harvest
Log off
Config
226
228
Close

FIG. 5B

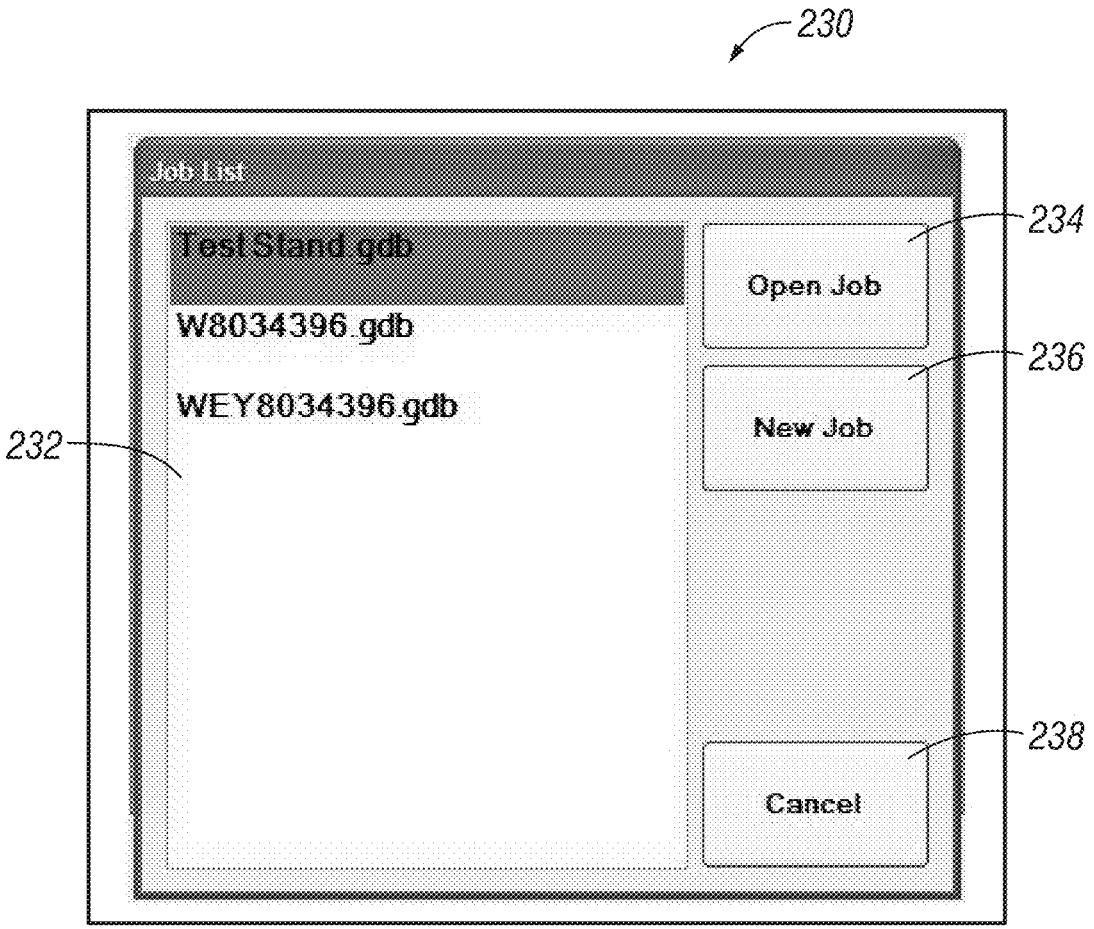
230
Job List
Test Stand.gdb
W8034396.gdb
WEY8034396.gdb
232
Open Job
234
New Job
236
Cancel
238

FIG. 6

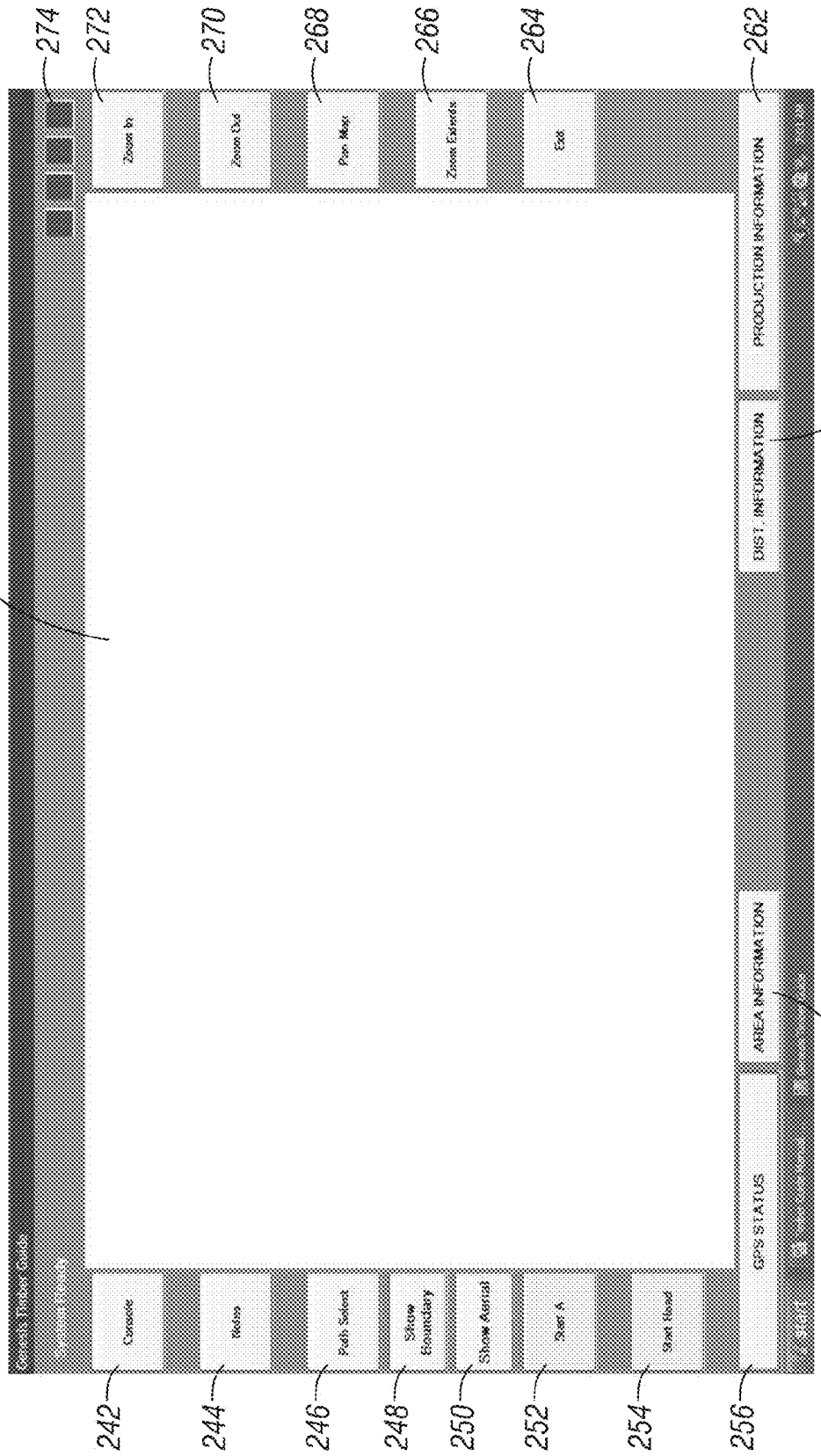
240
276
274
272
270
268
266
264
262
260
258
242
244
246
248
250
252
254
256
Zoom In
Zoom Out
Pan Map
Zoom Extents
Exit
PRODUCTION INFORMATION
DIST. INFORMATION
AREA INFORMATION
GPS STATUS
Console
Notes
Path Select
Show Boundary
Show Aerial
Sat 4
Start Head

FIG. 7A

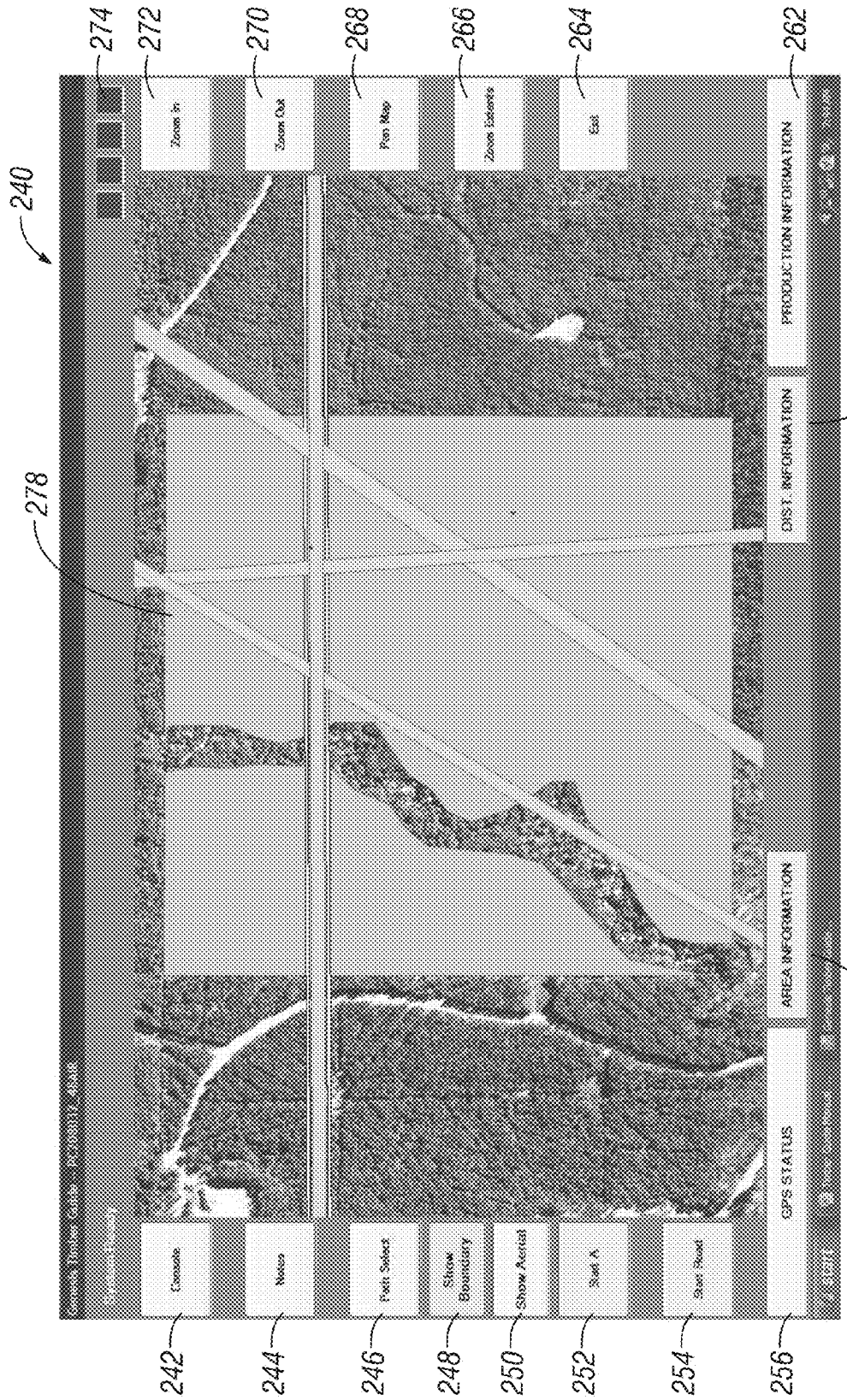
240
278
274
272
270
268
266
264
262
260
258
242
244
246
248
250
252
254
256
Zoom In
Zoom Out
Pan Map
Zoom Extents
Exit
PRODUCTION INFORMATION
DIST. INFORMATION
AREA INFORMATION
GPS STATUS
Execute
Notes
Path Select
Show Boundary
Show Aerial
Sort A
Sort Rand

FIG. 7B

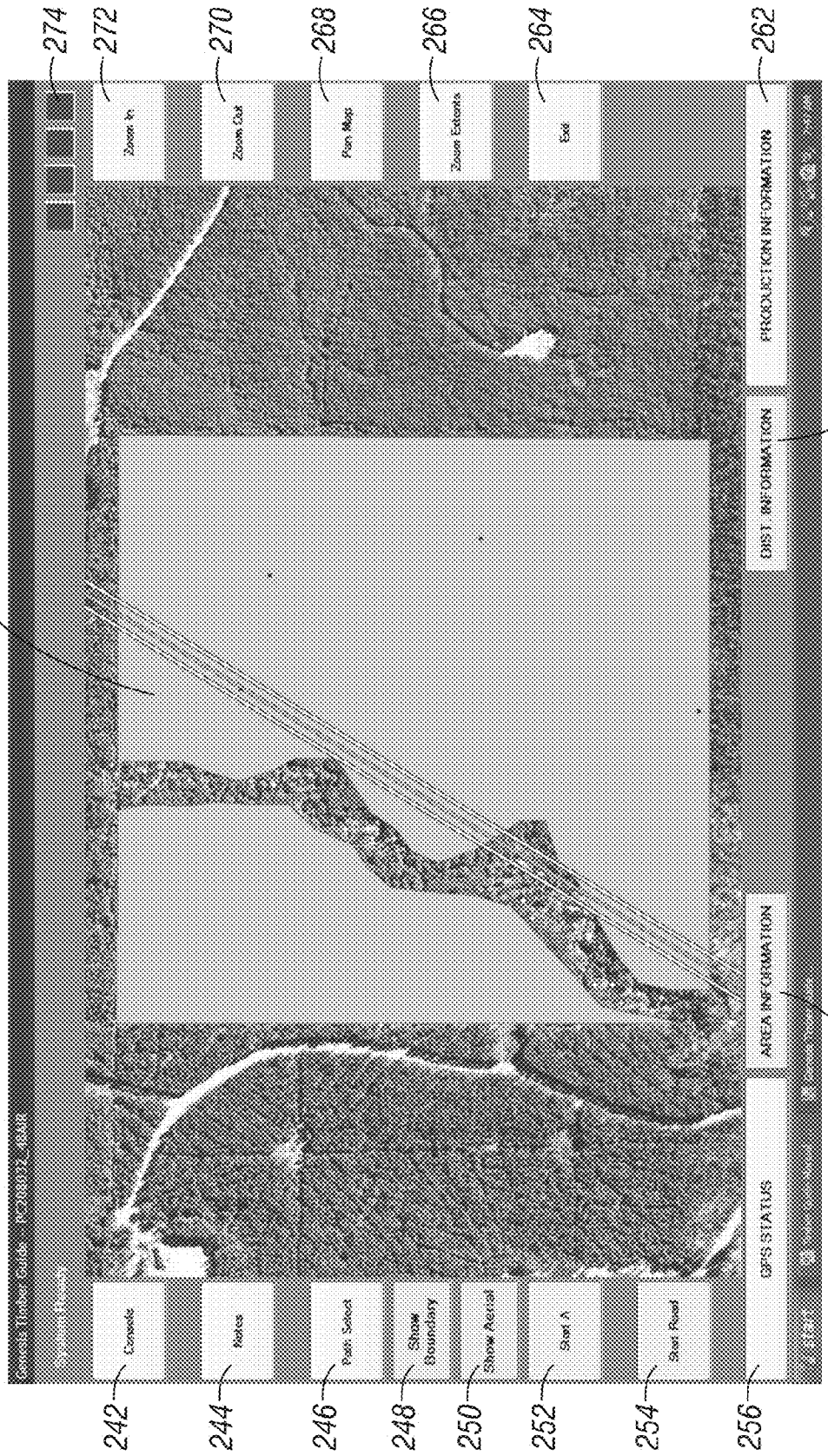
240
280
274
272
270
268
266
264
262
Zoom In
Zoom Out
Pan Map
Zoom Extents
Exit
PRODUCTION INFORMATION
260
DIST INFORMATION
AREA INFORMATION
258
GPS STATUS
Console
Notes
Path Select
Show Boundary
Show Aerial
Start A
Start Road
242
244
246
248
250
252
254
256

FIG. 7C

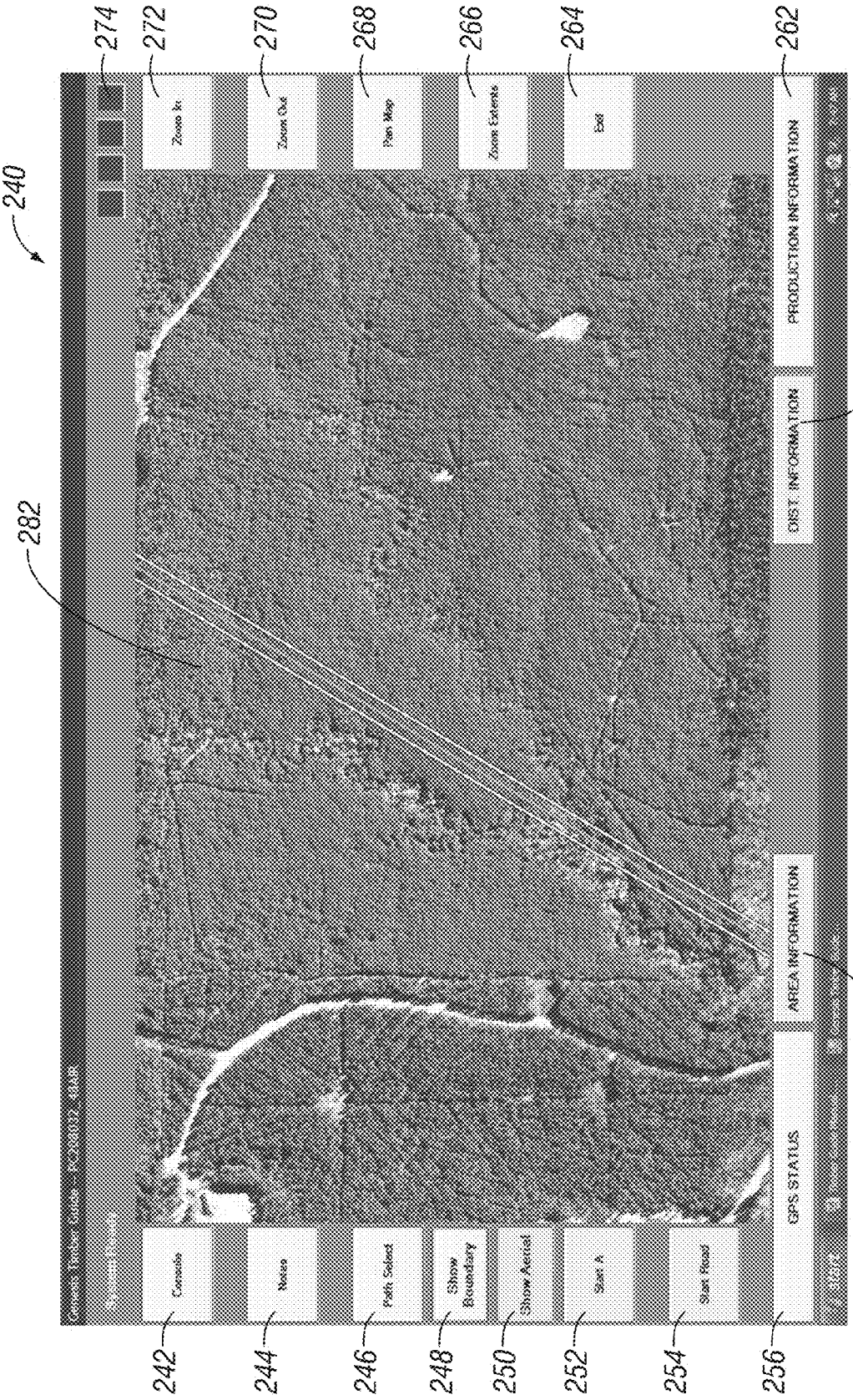
240
282
274
272
270
268
266
264
262
260
258
Zoom In
Zoom Out
Pan Map
Zoom Extents
Exit
PRODUCTION INFORMATION
DIST. INFORMATION
AREA INFORMATION
GPS STATUS
Controls
Notes
Path Select
Show Boundary
Show Aerial
Start A
Start Road
242
244
246
248
250
252
254
256

FIG. 7D

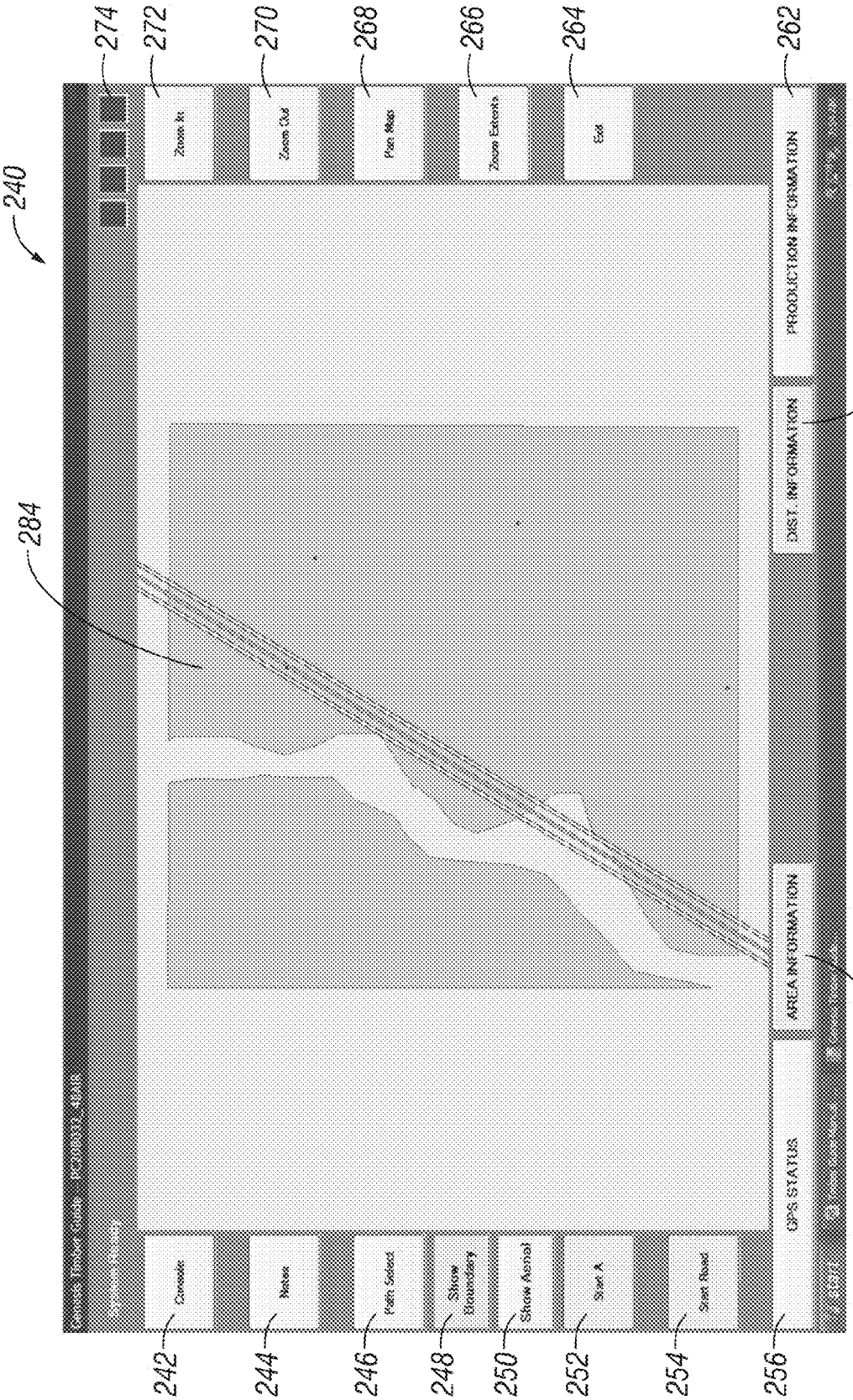
240
274
272
270
268
266
264
262
Zoom In
Zoom Out
Pan Map
Zoom Extents
Exit
PRODUCTION INFORMATION
260
DIST INFORMATION
284
AREA INFORMATION
258
GPS STATUS
Console
Notes
Path Select
Show Boundary
Show Aerial
Sort A
Sort Road
242
244
246
248
250
252
254
256

FIG. 7E

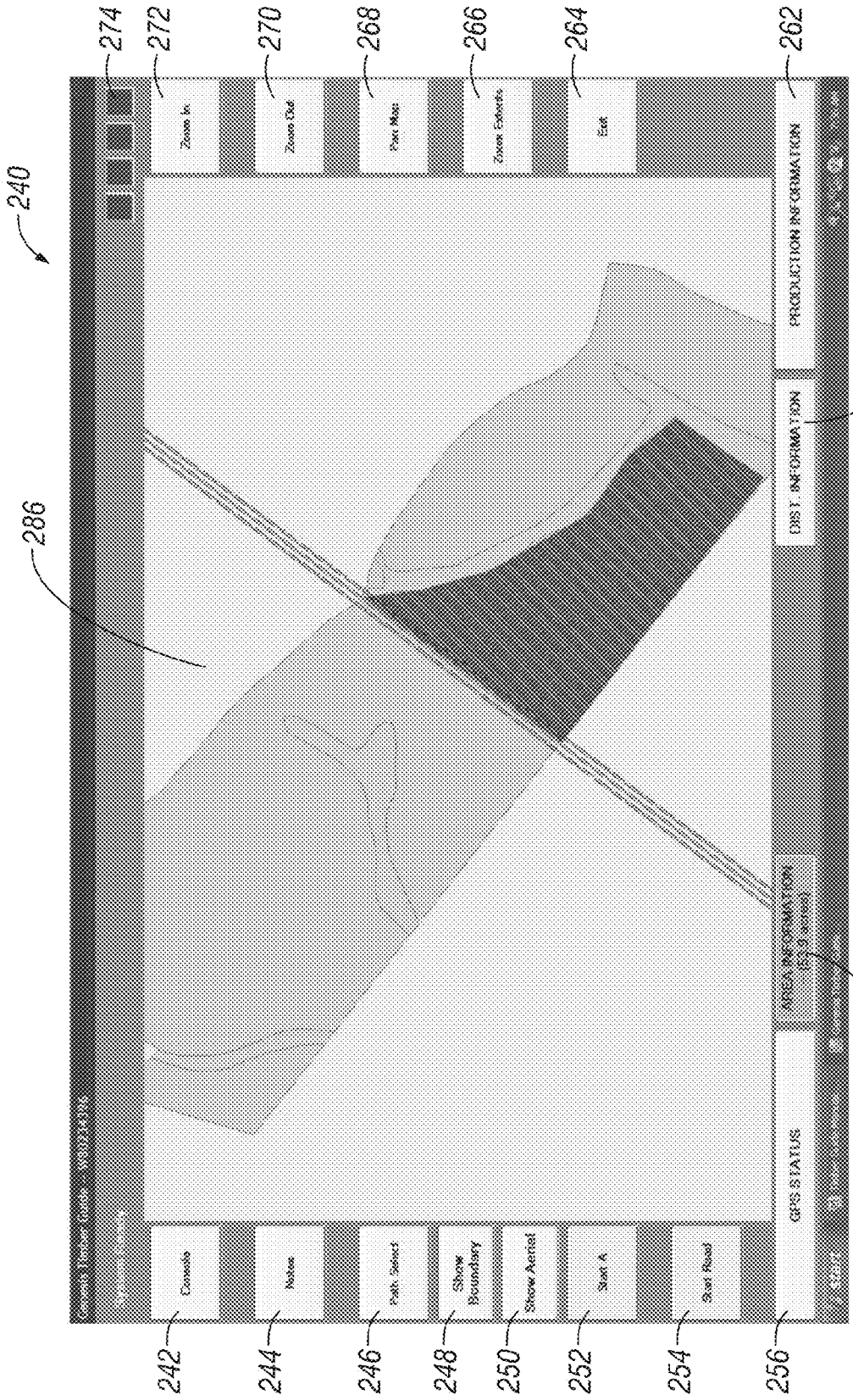
240
286
274
272
270
268
266
264
262
260
258
Zoom In
Zoom Out
Pan Map
Zoom Extents
Exit
PRODUCTION INFORMATION
DIRT INFORMATION
GPS STATUS
Console
Notes
Path Select
Show Boundary
Show Aerial
Start A
Start Road
242
244
246
248
250
252
254
256

FIG. 7F

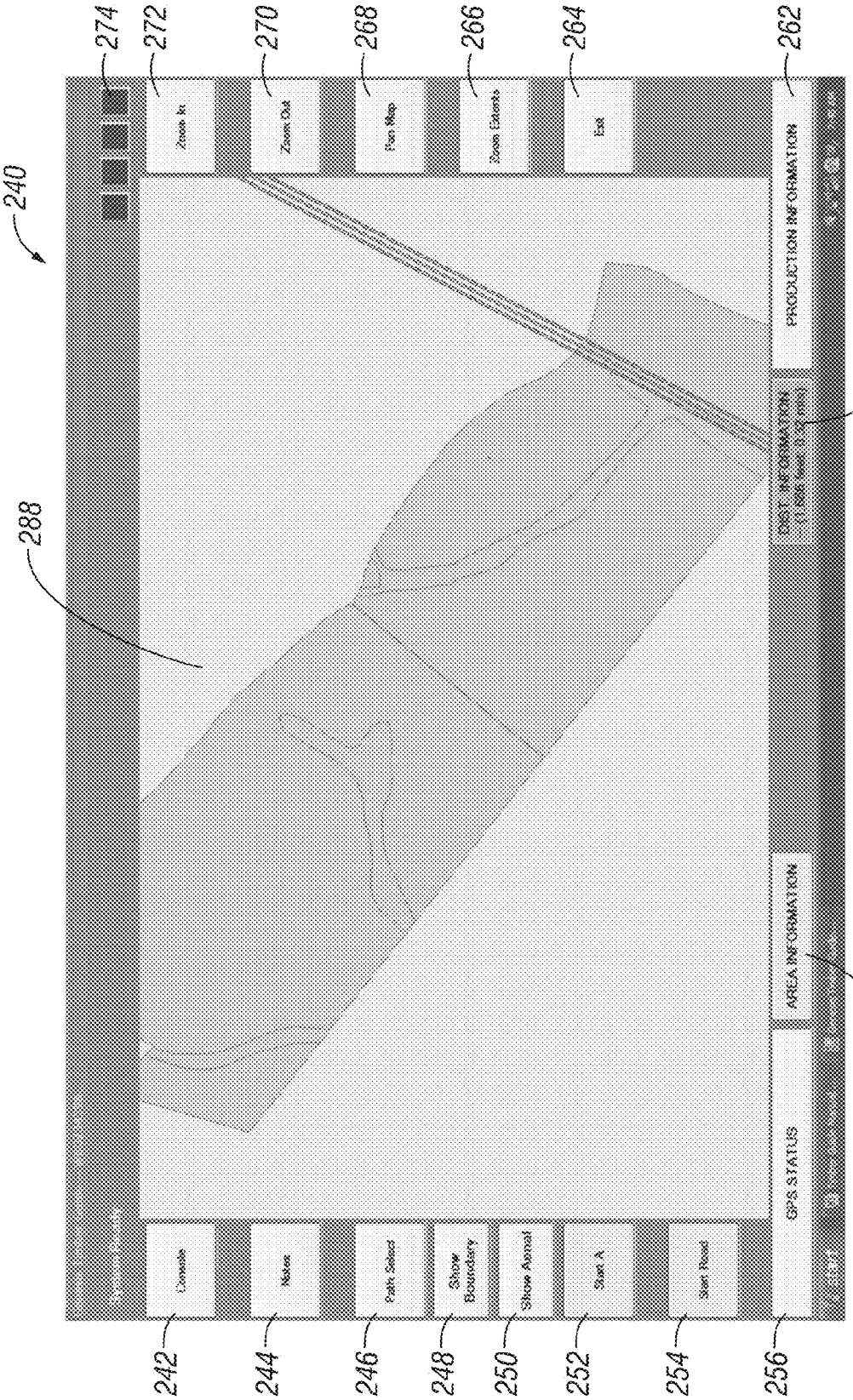
240
288
274
272
270
268
266
264
262
260
258
242
244
246
248
250
252
254
256
Zoom In
Zoom Out
Pan Map
Zoom Extents
Exit
PRODUCTION INFORMATION
DIGIT INFORMATION
AREA INFORMATION
GPS STATUS
Console
Notes
Path Select
Show Boundary
Show Aerial
Start A
Start Root

FIG. 7G

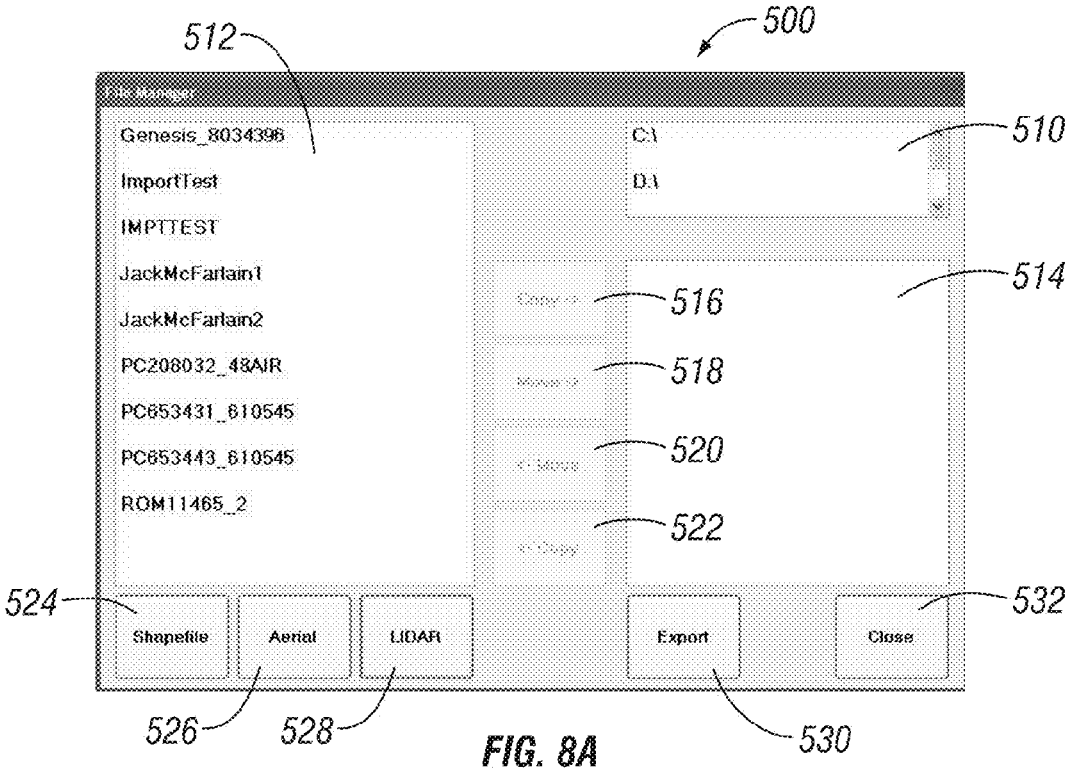
500
512
510
514
516
518
520
522
524
526
528
530
532
Genesis_8034396
ImportTest
IMPTTEST
JackMcFarlain1
JackMcFarlain2
PC206032_48AIR
PC653431_610545
PC653443_610545
ROM11465_2
C:\
D:\
Shapefile
Aerial
LIDAR
Export
Close

FIG. 8A

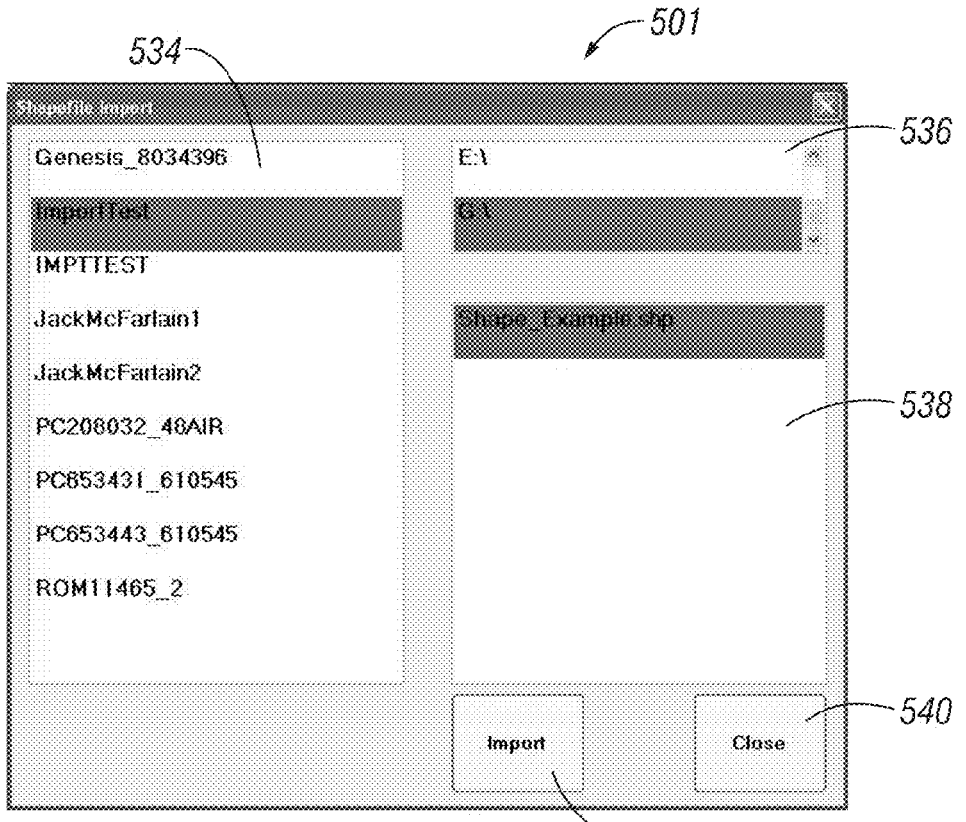
501
534
536
538
540
542
Shapefile Import
Genesis_8034396
ImportTest
IMPTTEST
JackMcFarlain1
JackMcFarlain2
PC206032_48AIR
PC653431_610545
PC653443_610545
ROM11465_2
E:\
G:\
Shape_Example.shp
Import
Close

FIG. 8B

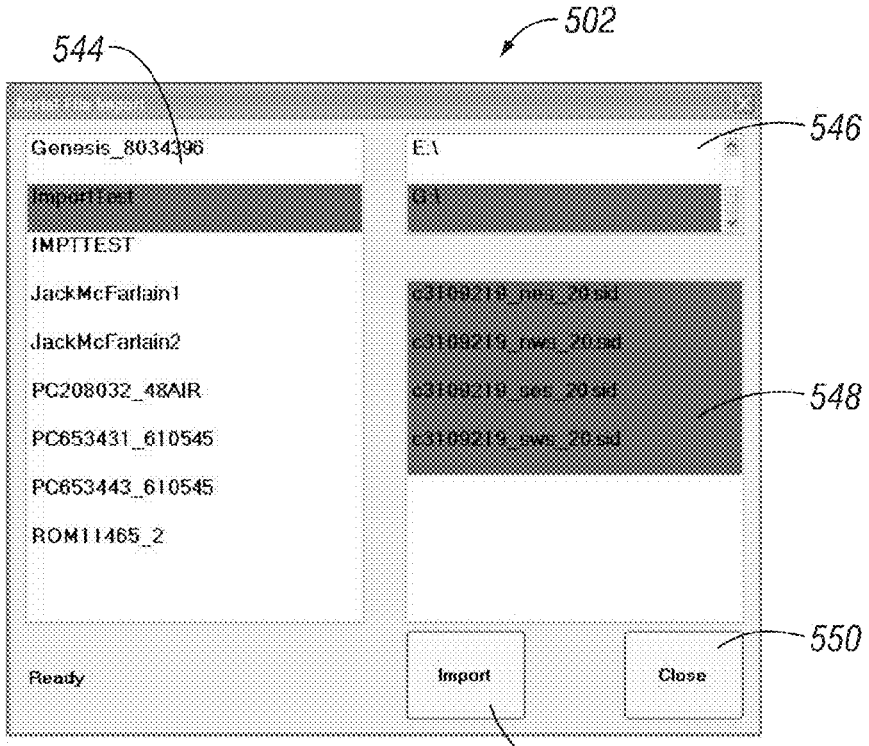
502
544
546
548
550
552
Genesis_8034396
E:\
IMPTTEST
JackMcFarlain1
JackMcFarlain2
PC208032_48AIR
PC653431_610545
PC653443_610545
ROM11465_2
Ready
Import
Close

FIG. 8C

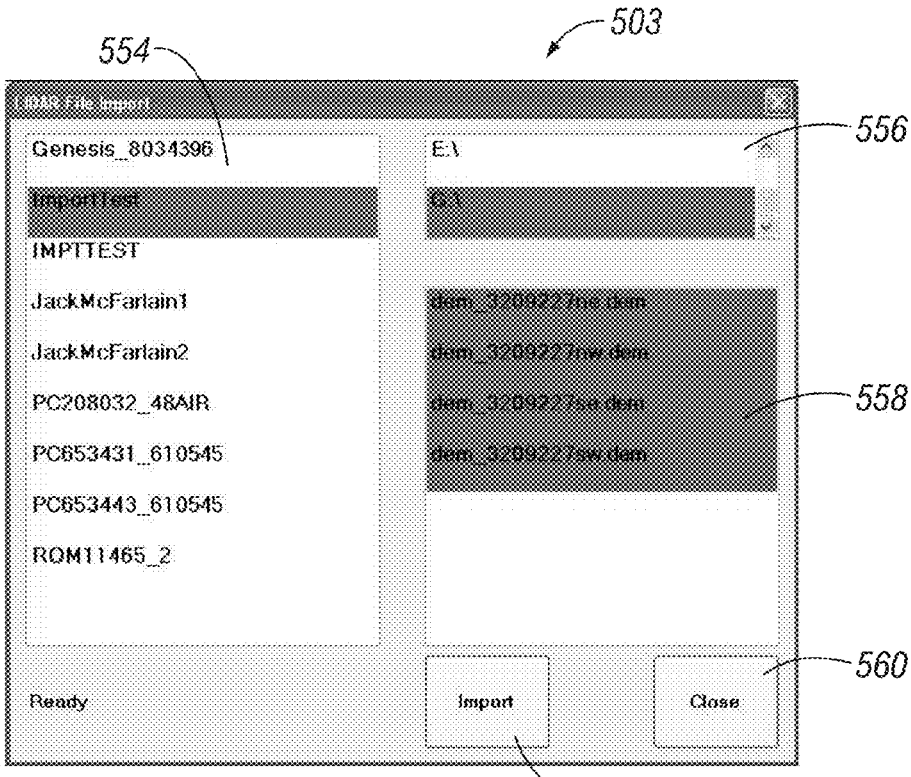
503
554
556
558
560
562
Genesis_8034396
E:\
IMPTTEST
JackMcFarlain1
JackMcFarlain2
PC208032_48AIR
PC653431_610545
PC653443_610545
ROM11465_2
Ready
Import
Close

FIG. 8D

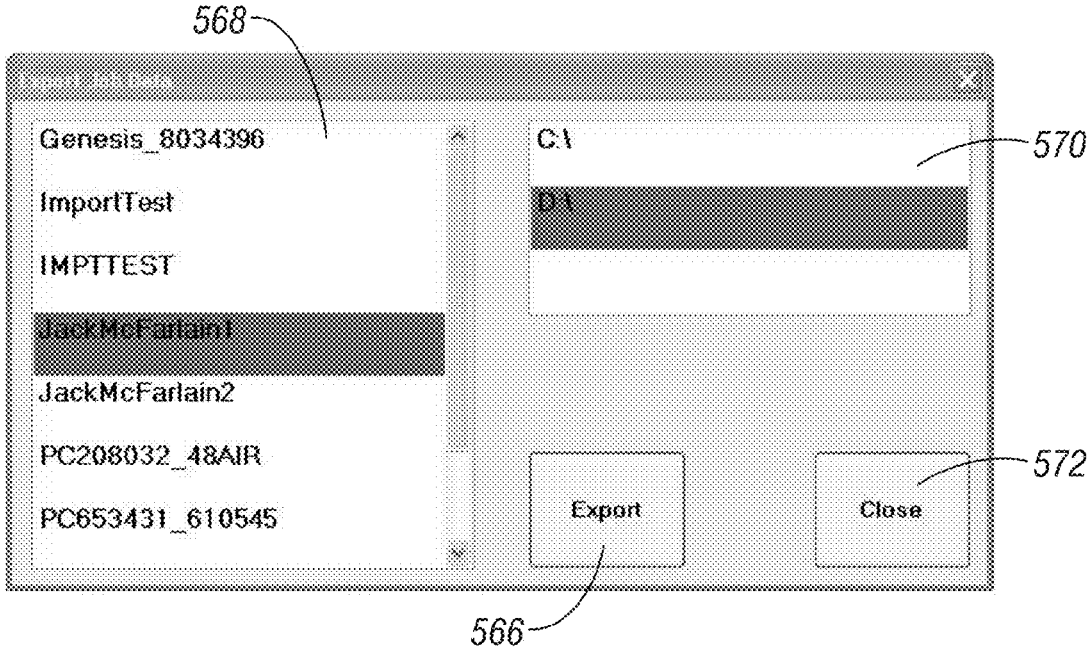
568
Genesis_8034396
ImportTest
IMPTTEST
JackMcFarlain1
JackMcFarlain2
PC208032_48AIR
PC653431_610545
C:\
D:\
570
Export
Close
572
566

FIG. 8E

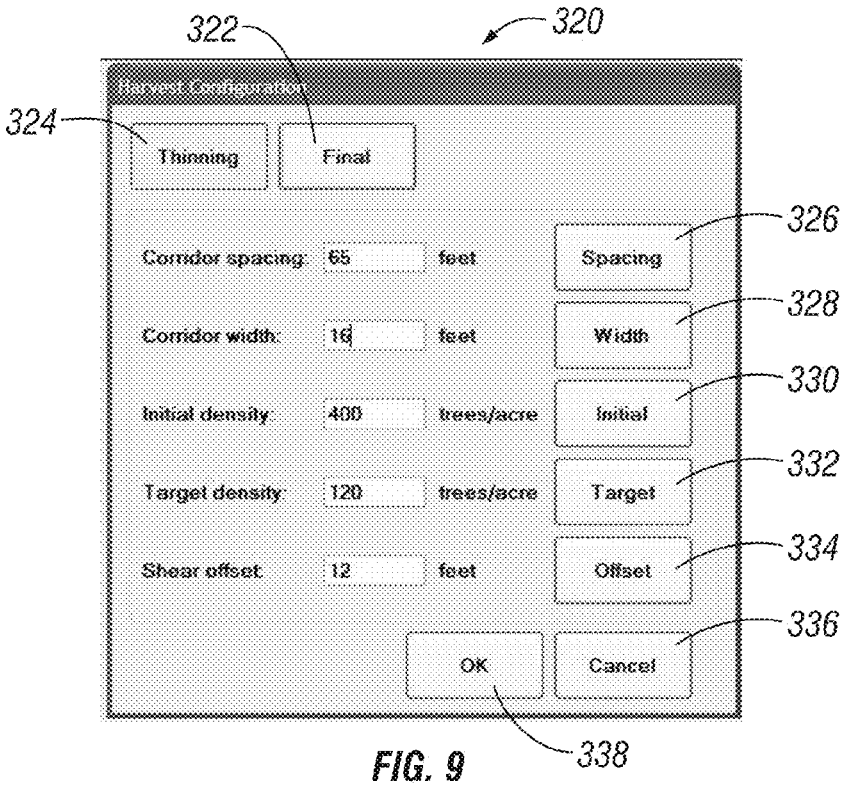
322
320
324
Thinning
Final
Corridor spacing: 65 feet
Spacing
326
Corridor width: 16 feet
Width
328
Initial density: 400 trees/acre
Initial
330
Target density: 120 trees/acre
Target
332
Shear offset: 12 feet
Offset
334
OK
Cancel
336
338

FIG. 9

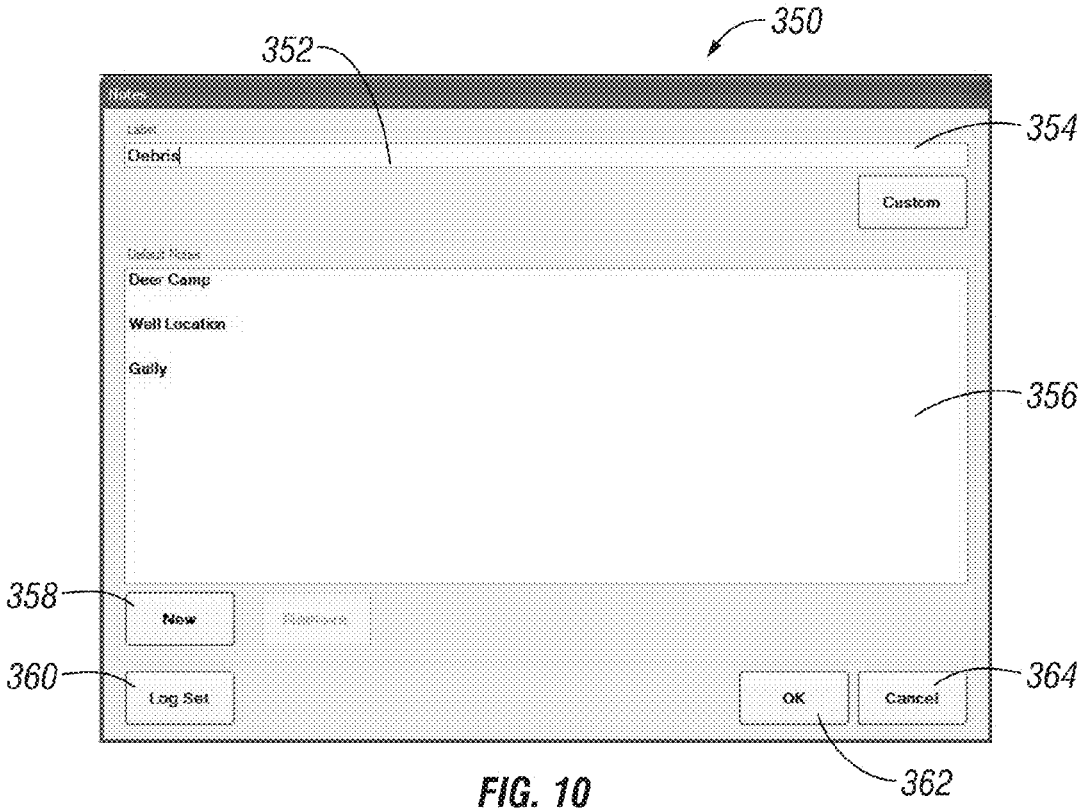
350
352
Debris
354
Custom
Deer Camp
Well Location
Gully
356
358
New
360
Log Set
OK
Cancel
364
362

FIG. 10

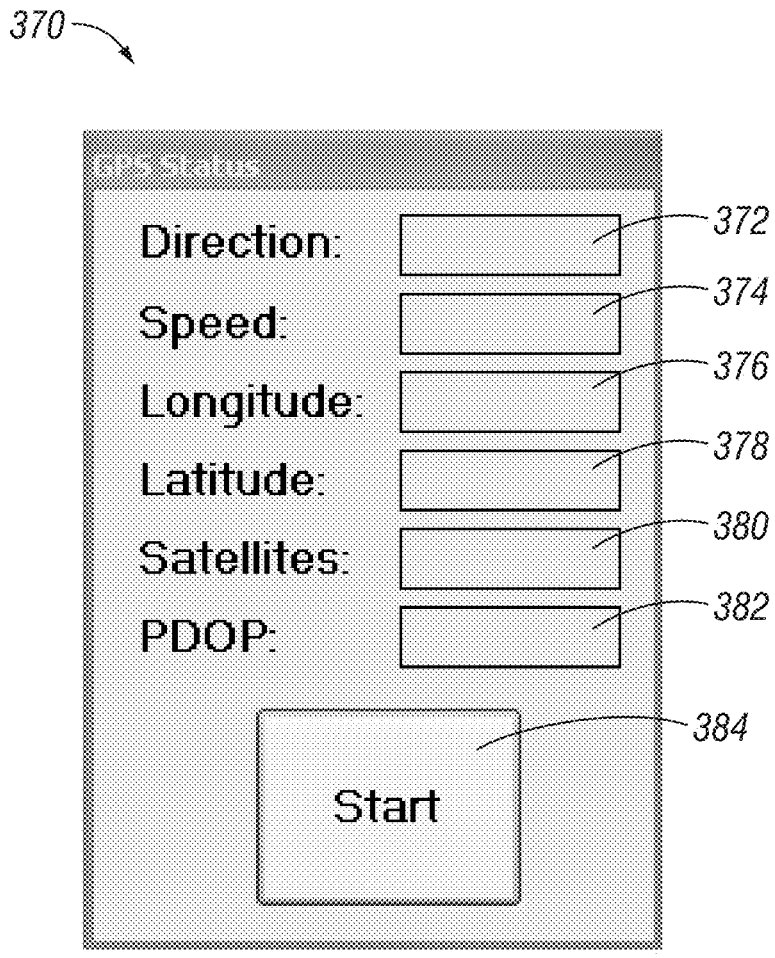
370
Direction:
372
Speed:
374
Longitude:
376
Latitude:
378
Satellites:
380
PDOP:
382
Start
384

FIG. 11

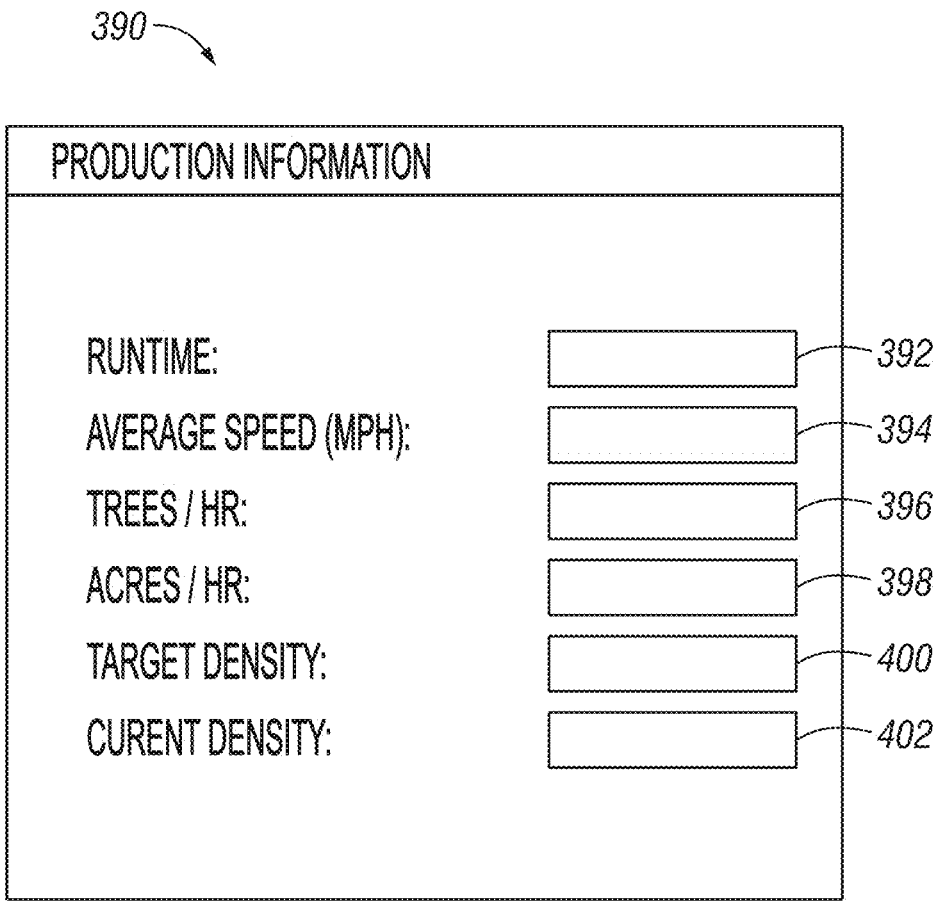
390
PRODUCTION INFORMATION
RUNTIME:
AVERAGE SPEED (MPH):
TREES / HR:
ACRES / HR:
TARGET DENSITY:
CURENT DENSITY:
392
394
396
398
400
402

FIG. 12

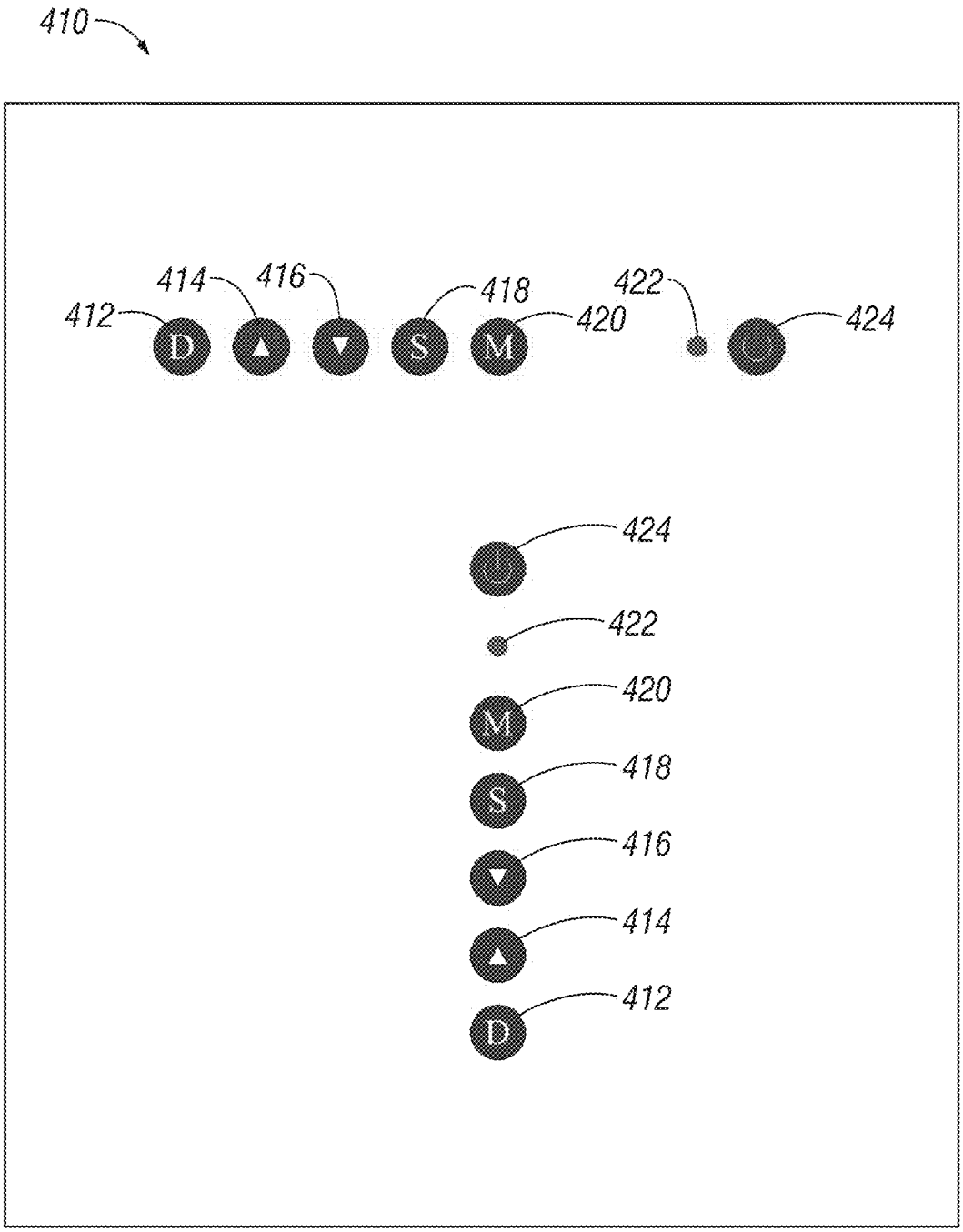

FIG. 13

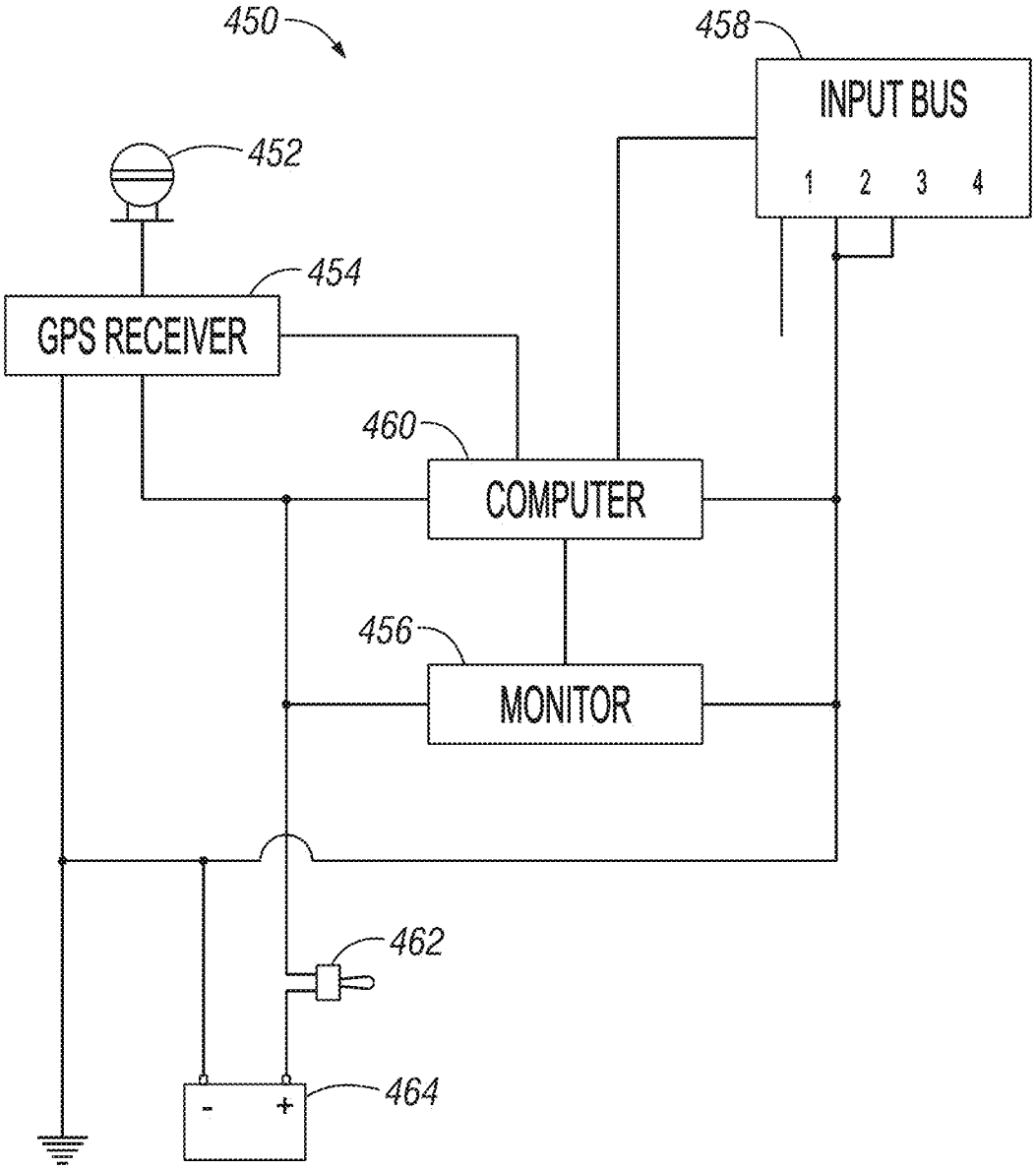
450
458
INPUT BUS
1 2 3 4
452
454
GPS RECEIVER
460
COMPUTER
456
MONITOR
462
464
- +

FIG. 14

MANAGING LANDBASES AND MACHINE OPERATIONS PERFORMED THEREON

FIELD OF THE INVENTION

The present invention relates to a method for management of land bases and machine operations performed thereon.

BACKGROUND OF THE INVENTION

The background of the invention is generally provided in the context of forest management. However, it is to be understood that forest management is merely one type of land management. Regarding forest management, historical land management practices have relied on data that contains an inherent amount of inaccuracy with regards to land boundaries, buffered areas, road utilization zones, and general forest area composition. The mechanisms for managing this inaccuracy and means for correcting it vary, and have included but not been limited to: United States Geological Survey maps, land ownership maps, traditional methods of surveying, collection of hand mapped GPS data, creation of boundary shape files utilizing remote sensing photographs and/or images. Remote sensing data utilized has included, but not been limited to: airborne and satellite based passive sensing utilizing electromagnetic wavelengths from the ultraviolet (UV–0.24 μm) through the far infrared (FIFR—1 mm) spectrum to create photographs and digital imagery as well as active sensors including, but not limited to airborne and satellite based RADAR (RAdio Detection And Ranging) and LIDAR (LIght Detection And Ranging).

Often land management data accuracy is corrected through remote sensing or hand mapping after practices such as a final timber harvest or thinning operations, which then show clearly the delineation lines such as boundaries, natural obstacles or out pieces, and environmentally sensitive areas. These practices, however serve as historical accounts of what has occurred, not what is occurring. This occurrence is in reference to management practices including, but not limited to timber harvesting and best management practices such as bulldozer work for remediation after harvest operations. These mechanisms for correcting the accuracy of land base data are often slow, costly and can be delayed by adverse weather conditions such as cloud cover in the case of remote sensing.

A major concern associated with delays in correcting management data, is subsequent operations that rely on this data and the potential economic and environmental impact of inaccurate information. With operations such as fertilization, competitive vegetation management, mechanical site preparation and planting, significant costs are incurred by the land owners or managing entities with each operation. For every acre of land that is improperly managed or accounted for, there is an associated cost. Sensitive areas such as streamside management zones (SMZ's) or protected wildlife areas may possess no potential economic return despite receiving additional inputs such as fertilizer or herbicide. Additionally, there may be negative environmental impacts such as surface water contamination with fertilizer or non-target injury of non-crop trees such as hardwoods in the SMZ.

Aside from the negative impacts associated with poor data in forest management activities, there exists the issue of improper asset valuation in timber stands derived from the classification of land as either productive "crop" areas or environmental management areas such as SMZ's. Additionally, certain areas within productive crop areas may have been damaged due to insect infestations, fires, or flooding, rendering them non-productive until the next crop rotation. Depending on the level and direction to which the information is skewed, this can dramatically impact investment firms, landowners, or individual investors in either a positive or negative direction with regards to the overall value of any particular owned quantity of land.

Furthermore, harvesting practices associated with timber production have suffered greatly in terms of production efficiency as a result of suppressed operator situational awareness in wooded settings. Due to the reduced sense of awareness an equipment operator may experience, with regards to his or her specific location within a defined parcel of property, a diminished level of equipment production efficiency as a result of the reoccurring act of identifying and verifying ones exact position or the direction in which to proceed with a prescribed activity. In other words, an operator may not be able to see the proverbial forest for the trees.

This level of confusion or inefficiency often results in, but is not limited to: the incomplete harvesting or maintenance of specified areas, inaccurate delineation of areas that are harvested, suboptimal layout and design of harvest or maintenance activities, incomplete harvest cycles with harvested timber not being retrieved for delivery to mills, inaccurate estimates of projected completion times, or improper allocation of logistics resources such as trucking.

Efforts to counteract the previously mentioned inefficiencies have included, but were not limited to the use of: printed paper maps comprised of remote sensing photogrammetry or imaging, existing shape files, digitized or hand drawn sketches placed in the possession of equipment operators, physical pre-operation site evaluations and orientations, utilization of colored paint or flagging for boundary identification, or point specific verbal and visual notifications conducted by the managing authority over specific properties. These solutions each contain a significant level of ineffectiveness due to errors in either information interpretation or the inability to transfer properly the actual physical location of an operator or equipment to the reference point on the associated support documents.

More specific to the logistics associated with product movement, estimates are made regarding the volume of product currently available for transport and then either turned into dispatch for transport resource allocation or a contract harvester utilizes one's own transport fleet. In terms of dispatch transportation the "estimation" often resulted in the inappropriate allocation of trucks for transporting the available product to processing centers which in turn results in increased transportation costs or decreased production at the harvest site with either too many or too few trucks being dispatched.

Therefore, it is a primary object, feature, or advantage to provide an on board operator interface with all available property parcel database information such that this is made available to equipment operators at the point and time of harvest.

It is a further object, feature, or advantage of the present invention to provide real-time visual referencing of equipment and operators in relation to specified boundaries and any known or previously recorded features of any specified parcel of property.

It is a further object, feature, or advantage of the present invention to provide real-time visual referencing and position of equipment and operators in relation to one another.

It is a still further object, feature, or advantage of the present invention to provide a real-time display for equipment

operators of the relative location of all electronically tagged ground personnel working in close proximity to forest management equipment.

Yet another object, feature, or advantage of the present invention is to provide for real-time documentation and mapping of actual forest management events and activities.

A still further object, feature, or advantage of the present invention is to provide equipment operators with a GIS application.

Another object, feature, or advantage of the present invention is to provide yield monitoring based on extrapolation or direct sensing to develop forest productivity models which may be used in developing maps for variable rate applications with regards to fertilization or herbicide applications.

Yet another object, feature, or advantage of the present invention is to provide a real-time data log, which may be used for determining the "actual" operational efficiency of equipment with regards to the performance of the exact task for which said equipment was designed vs. actual total time of operation over any pre or post determined period of time.

A further object, feature, or advantage of the present invention is to provide for estimated volume calculation of raw goods available for transportation at a centralized loading point in field locations on any specified parcel of property resulting from the data generated by the combination of the various systems on individual machines in a harvesting operation.

A still further object, feature, or advantage of the present invention is to provide real-time wireless or manual transfer of all available data between all operational aspects of land management which may include, but not be limited to, equipment operations, supervisory personnel, logistic activities, and central land management databases.

Another object, feature, or advantage of the present invention is to provide real-time tracking and evaluation of all equipment and individuals associated with any specified forest management operation providing the ability to view and manage any combination of activities from a remote location in an effort to optimize the efficiency, profitability, quality, and/or safety of specified activities.

Yet another object, feature, or advantage of the present invention is to provide reconciliation of paperwork associated with logistic processes such as transportation through the uses of all associated land base information which may include but not be limited to timber tract loading location(s), load numbers, mill destinations, time and date of origination, contractor information, landowner and manager information, and product type.

A further object, feature, or advantage of the present invention is to provide for product security through electronic tracking of transport equipment such as trucks with all associated product, land owner/manager, and contractor information tied to each specific load.

Yet another object, feature, or advantage of the present invention is to provide a simplified interface to a GIS application suitable for use when operating equipment which performs work operations on a land base.

One or more of these and/or other objects, features, or advantages of the present invention will become apparent from the description that follows. No single aspect or embodiment of the invention need exhibit every object, feature, or advantage set forth above.

BRIEF SUMMARY OF THE INVENTION

A method is provided for management of a land base; wherein, operations are performed on the land base by equipment operated by an operator. The method includes a computer running a Geographical Information System (GIS) application which senses an operational function or functions of the piece of forestry equipment. Upon sensing the function or functions performed by the piece of forestry equipment, the computer stores the operation as map points, lines, or polygons on at least one data layer within the GIS application, and displaying the GIS application to the operator at the location and time of performing the operations.

According to another aspect of the present invention, a system for management of a land base is provided. The system includes a self-propelled machine for performing land management operations on the land base, a computer operatively connected to the self-propelled machine, a GIS application executing on the computer, and a geoposition determining device in operative communication with the computer. There is at least one machine sensor operatively connected to the self-propelled machine and in operative communication with the computer for sensing the land management operations performed by the self-propelled machine on the land base. The GIS application is adapted to display a map and a plurality of layers of data on the map. At least one of the pluralities of data layers comprises data indicative of the land management operations performed by the self-propelled machine on the land base.

According to another aspect of the present invention, a method for management of a land base wherein work operations are performed on the land base by a machine operated by an operator is provided. The method includes interfacing the machine to a computer using a bus module electrically connected between the machine and the computer, and placing a geographical information system (GIS) application on the computer such that the computer is configured to monitor the operations and store data about the operations as map points, lines, or polygons on at least one data layer within the GIS application. The method further includes displaying the GIS application to the operator on a touch screen display at the location and time of performing the operation. The GIS application includes a plurality of data layers, including at least one data layer comprising data for work operations performed by at least one additional machine.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of one embodiment of a system of the present invention.

FIG. **2** is a block diagram of a machine configured for use with a GIS software application.

FIG. **3** represents the field communication network (example of a harvest system utilizing multiple harvesters and skidders.

FIG. **4** is a screen display showing a login window.

FIG. **5**A is a screen display of an operator setting window.

FIG. **5**B is a screen display of a configuration window.

FIG. **6** is a screen display showing a job list window.

FIG. **7**A-G illustrates a main screen display for a GIS application.

FIG. **8**A-E provide screen displays associated with the GIS application.

FIG. **9** is a screen display associated with a harvest configuration.

FIG. **10** is a notes interface screen display.

FIG. **11** is a GPS status screen display.

FIG. **12** is a Production Information screen display.

FIG. **13** is a monitor screen display.

FIG. **14** is a block diagram showing one embodiment of a machine.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

I. Overview

The present invention applies a new approach to the activities associated with land management. The present invention relates to recording, documenting, processing, correcting, managing, and sharing all information regarding any management activities that deal with the direct interaction of equipment and people with land, natural resources, or recreational areas. The present invention may be used as a part of a complete system to collectively interact with and aid in managing all aspects and operations simultaneously. Alternatively, different aspects of the invention may be used separately. The present invention may provide advantages relating to enhancing individual equipment productivity, increasing operator safety, increasing operational efficiency, increasing security, or increasing overall quality of operations regarding land stewardship.

One aspect of the present invention allows for the data collection to be performed at the location and time of need, such as by equipment used in forest harvesting or other land management activities. Instead of merely collecting data, and later reconciling with other information, or later communicating to a home office, once collected, the data can be displayed and used to promote efficiencies in forest harvesting or other land management processes.

FIG. **1** provides an overview of one embodiment of the present invention. In FIG. **1**, a system **10** is shown. The system **10** shown includes a first machine **12**A, a second machine **12**B, and a third machine **12**C. Of course any number of machines may be used. Each machine **10** is configured for operating a GIS application **16**A, **16**B, **16**C. In addition, a remote location **18** is shown. The remote location **18** may be a home office, but need not be. The remote location **18** also has an associated GIS application **16**D. The machines **12**A, **12**B, **12**C operate on a land base performing work operations. In addition to the machines **12**A, **12**B, **12**C, there are workers **14**A, **14**B on the land base. Although two workers are shown, of course there may be additional workers present. Real-time communications occur between the machines **12**A, **12**B, **12**C and equipment **15**A, **15**B associated with the workers which may include RFID tags, beacons, transmitters, or transceivers with or without GPS enablement for tracking positions of the workers. In addition, the equipment **15**A, **15**B may include handheld terminals. In this way, the location of the workers can be identified and communicated to the machines **12**A, **12**B, **12**C. In addition, each machine **12**A, **12**B, **12**C communicates information between itself and other machines. The information transmitted preferably includes data points regarding each machine's performance and/or location of work operations, or other information that may be saved or stored in a layer of the GIS applications **16**A, **16**B, **16**C, **16**D. In addition, each machine **12**A, **12**B, **12**C may save this information locally.

A dispatch station **22** may be in operative communication with one or more of the machines **12**A, **12**B, **12**C. The dispatch station may dispatch trucks **20** or other vehicles to pick up loads of timber for delivery to a mill **24**. The present invention allows for real-time reporting. For example, an estimated volume may be calculated for raw goods available for transportation at a centralized loading point in field locations on any specified parcel of property resulting from the data. This information may be communicated to or calculated by the dispatch station **22**, the trucks **20**, or the mill **24**.

The remote location **18** may use data associated with its GIS application **16**D to generate reports associated with different tracts of lands, job sites, or field operations. Of course, reporting may also take place using the GIS applications **16**A, **16**B, **16**C associated with machines **12**A, **12**B, **12**C. The reporting may include detailed processing and analysis performed during or after operations associated with a particular land base.

II. Machine Operation

FIG. **2** illustrates a system **50**. The system **50** includes a land management machine **52** such as, but not limited to, self-propelled machines used in timber harvesting such as feller bunchers, skidders, loaders, as well as machines such as bulldozers used to perform land management operations. A computer **54** is operatively connected to the machine **52**. One method of connecting the computer **54** is to use a bus module **53** to transform electrical impulses associated with operational functions into signals capable of being accepted by the computer **54**. The computer has an associated display **66**. There is a geographic information system (GIS) software application **64** executing on the computer **54**. The GIS software application **64** may be based on an ArcGIS software application or any other type of commercially available GIS application. One or more sensors **56**, **58** are also operatively connected to the machine **52** and are in operative communication with the computer **54**. The sensors **56**, **58** may be of various types for various purposes, the type and purpose may be determined by the particular type and function of the machine **52**. For example, where the machine **52** is a feller buncher, the sensor may be a sensor that senses closing of the arms which is associated with cutting of a tree. Similarly, where the machine **52** is a skidder, the sensor **56** or the sensor **58** may be a sensor that senses that a load of trees has been picked and/or released. Any number of sensors may be present. The sensor or sensors may also be functioning to determine the distance of the harvesting head from the GPS antenna in the case of tracked feller bunchers which utilize extendable arms or booms. The system **10** may also include a geolocation sensor such as a GPS receiver **62** which is operatively connected to the computer **54** or the machine **52**. The GPS receiver **62** provides a location signal which can be used to associate a time and location with data from the machine sensors **56**, **58**.

A wireless transceiver **60** is operatively connected to the computer **54**. The wireless transceiver **60** allows data to be exchanged between the machine, one or more additional machines, and/or said machines with additional personnel appropriately equipped with personal computer and or other personal wireless data collection devices. The wireless transceiver **60** may be of any number of types, such as, but not limited to a radio transceiver, a cellular transceiver, a satellite transceiver, or other type of transceiver.

The machine **50** allows for performing land management and related activities in a manner in which data associated with the land management activities may be collected, including time and location data determined using the GPS receiver **62**, and data from the machine sensors **56**, **58**. There may be any number of sensors or any number of types of sensors. This data collected may then be placed within one or more layers of data associated with the GIS application **64**. Maps with the one or more layers of data may be shown on the display **66** to assist an operator of the machine **52**. The display **66** is preferably a touch screen display. In addition, the data may be stored locally or communicated over the wireless transceiver **60** to one or more other machines or to other remote locations.

Although a wireless transceiver **60** is shown, the present invention contemplates that in some applications data may be stored on removable media, such as USB drives and transferred from one machine to another machine.

As shown in the system of FIG. **2**, an on board operator and equipment interface provides all available property parcel GIS database information to the operator while the operator is performing work operations on the land base. The GIS application which is a part of this interface allows for real-time visual referencing of equipment and operators in relation to specified boundaries and any known or previously recorded features of any specified parcel of property. The display on the operating equipment monitor allows for displaying the relative location of electronically tagged ground personnel working in close proximity to forest management equipment.

An operator of the machine thus has access to real-time documentation and mapping of actual land management events and activities. The GIS application allows for fully interactive operator use of any predefined and or modified functions associated with the GIS application. Examples of such functions include, without limitation, on screen creation of polygons for area determination, distance measurement tools, remote sensing imagery overlays, polygon/shape file incorporation which may encompass any or all know information or features of any designated parcel of property, general topographical map overlays, guidance tools for standardizing travel path directions and spacing. The GIS application also allows for machine or equipment operation or activity mapping points, lines, or polygons with the associated time and date. Examples of such activities may include, without limitation: harvested trees; laid down bundles of trees; trees per bundle laid down; retrieved bundles of trees with associated tree count; loaded forestry products; delivered forest products; creek (SMZ) crossing locations; road system construction and utilization; use frequency in equipment traffic zones; snow grooming areas and activities; fire line construction and maintenance; gas pipeline or utility construction areas; mapping of discovered invasive or exotic plant areas; mapping of discovered endangered plant and animal species; extrapolated areas of excessive wheel slip, rutting or other environmental disturbances; corrective best management practices (BMP's); construction of water bars; road or log set maintenance; and SMZ crossing maintenance activities.

Data regarding any number of activities associated with equipment interaction may be collected. This may include general activities involving equipment interaction with land and natural resources as well as the associated covering such as snow and natural or unnatural debris. In addition, information such as yield monitoring based on extrapolation or direct sensing to develop forest productivity models which may be used in developing maps for variable rate applications with regards to fertilization or herbicide applications. In addition, a real-time data log may be used for determining the operating efficiency of equipment with regards to the performance of the exact task for which said equipment was designed vs. actual total time of operation over any pre- or post-determined period of time. Specific and general examples may include but are not limited to: tree harvester time spent harvesting vs. total time operating;

tree retrieval equipment time spent retrieving vs. total time operating; and specific task operation of equipment vs. total operating time of equipment.

As shown in FIG. **2**, real-time wireless transfer of all available data may be made between all operational aspects of land management which may include, but not be limited to, equipment operations, supervisory personnel, transportation of goods, and central land management databases. Alternatively, data may be loaded onto a USB drive or other type of removable storage and transferred. In addition, where a wireless transceiver is associated with each machine, the present invention allows for real-time tracking and evaluation of all equipment and individuals associated with any specified forest management operation providing the ability to view and manage any combination of activities from a remote location in an effort to optimize the efficiency, productivity, profitability, quality, and safety.

The present invention also provides for reconciliation of paperwork associated with logistical processes such as trucking through the uses of all associated land information which may include but not be limited to product origination location, load numbers, mill destinations, time and date of origination, contractor information, landowner and manager information, and product type. The present invention further provides for product security through electronic tracking of transportation equipment such as trucks with all associated product, land owner/manager, and contractor information tied to each specific load.

The present invention uses a software application which provides a new approach to acquiring and implementing the data associated with forest management practices. The software application provides a direct interface between the operating systems associated with forest management equipment, a GPS system, and a computing system capable of incorporating, displaying and allowing equipment operator interaction with all available electronically stored information associated with any specified parcel of property. Furthermore, the programs that the computing system incorporates include, but are not limited to, Windows XP operating systems and software which interacts and operates in conjunction with all aspects of a GIS application such as ArcGIS or other commercial GIS applications. The present invention further contemplates that the system for running the GIS application may be used for other purposes, such as controlling the machine.

The combination of software and hardware allows for the "real-time" collection of data regarding the operational events of forest management equipment that can and do impact the composition of the data being utilized for management decisions on any specified parcel of property as well as the logistical decisions made in managing the raw products obtained from this same stated parcel. Additionally, this "real-time" data management system records and documents discovered discrepancies that can and do exist within a landowner or managing entities known database of a specified parcel of property. The "real-time" transfer of data may also aid in logistics management with regards to the dispatch and tracking of transport services when used in conjunction with all other aspects of the present invention. It should be noted that the term "real-time" as used herein means real-time or near real-time such that data can be collected, and/or displayed at the location and time of use of equipment which performs operations on or associated with a land base.

The invention may be used as a fully integrated system or a standalone system, which may or may not be interfaced with any land management and or natural resource database being utilized to record, document, and store any event or activity that has or will transpire with regards to any specified parcel or collective parcels of land, along with their associated natural resources. The recorded and stored information may be used to correct or confirm the overall composition of any specified parcel or collective parcels of land. This composition refers to, but is not limited to the, natural or unnaturally defined boundaries, assets, natural resources, and or buffers of the stated parcel or parcels. Furthermore, the recorded data may be utilized in subsequent maintenance and or silvicul-

tural activities to enhance economic returns by optimizing the utilization of any inputs while at the same time minimizing negative environmental and natural resource impacts and/or maximizing positive environmental and natural resource impacts.

Additionally, the information derived from the recorded activities may be used to analyze any and all activities associated with the interaction of equipment and personnel with a single or collective parcel of land, which may be singularly or collectively owned by one or more entities to include but not be limited to: investment groups, government agencies, sole proprietorships, or corporate entities. The analyzed information may be used to create a complete analysis of either the total operational efficiency of a land management system or any single aspect of this said system.

The interpretation of this information may be used to enhance the overall or singular operational productivity, efficiency, profitability and quality of the previously stated system through an interactive database which is programmed to allow the user defined extraction of information for management decisions whether economical or environmentally based. This database may be, but is not limited to, a web based system which receives the collected data from all interactive operations and then stores the proprietary data in a database system on a server or some type of interactive computer system. This database may be accessed by each respective entity for implementation into their system. This database system may be essential or nonessential to the utilization and implementation of each specific unit of equipment incorporating data collecting and mapping hardware and software. The data collecting and display hardware and software incorporated into the equipment systems may serve as a collective or stand alone systems serving solely as navigational aids improving operational and logistical efficiencies, while reducing negative or improving positive economic, environmental or natural resource impacts.

The above stated system functions as a result of the incorporation of computing systems into all mechanized activities that may occur on a specified parcel of land. This interaction of computers and machines is accomplished through bus modules which translate the direct current (DC) voltage associated with a particular function or operation into a digital signal which the computer is able to accept and a specified GPS coordinate possessing four dimensional data consisting of time, latitude, longitude, and elevation for use in land and resource management. Furthermore, equipment operators may create and utilize nonstandard information fields for further documentation of activities as well as observations that may be of value in a land management database.

III. Timber Harvesting Operations

To provide a further example of the present invention, the present invention is described with respect to an embodiment which may be used for timber harvesting. FIG. **3** is a block diagram illustrating in more detail information flow associated with timber harvesting operations. As shown in FIG. **3**, there is a field communication network **100**. Main components of the field communication network **100** include a GIS/remote sensing imagery module **112**, a Timber Guide module **120**, a Data Export to Smart Phone/PDA module **130**, a Mill module **128**, a Server module **134**, and a Computer module **136**. The GIS/remote sensing imagery module **112** includes a shape file **114** which may be used to define boundaries of a tract of land or other land base, remote sensing imagery which may include an aerial file **116** which includes an aerial image of the land base and a LIDAR image file **118** which includes a topographical representation of the land base. Instead of a LIDAR image file, other topographical data may be used. The module **120** includes Skidders **122***a* and **122***b* which is any type of heavy vehicle used in a logging operation for retrieving cut trees out of a forest in a process called "skidding". Feller Bunchers **124***a* and **124***b* are logging machines with an attachment that harvests trees in place, and a Loader **126** is a piece of equipment utilizing an extendable boom similar to an excavator with a set of rotating tongs, or grapple, at the end to handle logs. The Data Export to Smart Phone/PDA/personal computer/personal data collection device module **130** includes, but is not limited to, tract data layers, load tickets, scale tickets and notes of interest. The Mill module **128** function is associated with a mill that processes timber. The Server module **134** includes Production Information **138** and GIS Data Layers **140**.

The various machines all utilize various data layers and information based on their function. Skidders **122***a* and **122***b* collect and maintain the data layers and information such as: on-site information center, shape file, remote sensing imagery such as aerial images, LIDAR/topographical information, bundles picked up, stream management zones (SMZ's) crossed and/or cleaned out, path's traveled, wheel slippage, travel speed and road mapping. Feller Bunchers **124***a* and **124***b* collect and maintain data layers and information such as tract shape file, remote sensing imagery, LIDAR/topographical information, A-B corridor guidance lines, trees harvested (production data derived from this layer), timber bundles laid down, road mapping, tonnage yield monitoring, 3D topographical display, and machine location recorded data. The machine location recorded data may include 4D GPS coordinates time/latitude/longitude/elevation, environmental impact monitoring, notes which include, but not limited to, the following: log sets, SMZ crossings and other points-of-interest (POI's) which include the following: endagered species, invasive species and hazards. A Loader **126** collects and maintains the following data layers and information: on-site information center, shape file, remote sensing imagery, aerial images, LIDAR/topographical information, bundles laid down, bundles picked up, equipment location, wheel slippage monitoring, tract/loader log database and wireless data export to smart phone/PDA/personal computer, personal data collection device. The Production Information module **138** may have three main components, statistics, image of harvested area and various data layers. The Statistics data may include, but is not limited to, production time, trees harvested during hour (production), trees harvested per hour (productivity), acres harvested. The image of harvested acres data includes GIS and remote sensing information. The various data layers data may include, without being limited to, harvested trees, timber bundles laid down, bundles picked up, notes and Sustainable Forestry Initiative (SFI) data. GIS Data Layers **140** may include main components, guidance paths, shape file of tract, trees harvested, timber bundles laid down, timber bundles picked up, road mapping, wheel slippage monitoring and notes. Notes includes log sets, SMZ crossing and other points-of-interest. Other points-of-interest includes endangered species, invasive species, hazards and unharvestable areas.

As shown in FIG. **4**, the login page **200**, has three components, the Admin/Operator box **202** a Login button **204** and a Cancel button **206**. Choosing Admin from the Admin/Operator box **202** allows a system administrator to add/change users (operators) or change/check system settings. The administrator area requires a password. This is to prevent any inadvertent changing of critical system settings. The system configuration comes preset from the factory. Choosing Operator Name from the Admin/Operator box **202** allows the operator to select his name by tapping name on screen and then taps the

Login button **204**. An operator's login can be password protected if so desired. Pressing the Login button **204** will advance to Job List screen **230**. Choosing the Cancel button **206** closes the Login page and goes to the main screen **240**.

As shown in FIG. **5**A and FIG. **5**B, the Settings and Configuration page **210** allows the operator to choose between the Job List screen **230** (FIG. **6**) by pressing the Job List button **212**, the System screen by pressing the System button **214**, the GPS Status screen **370** (FIG. **11**) by pressing the GPS button **216**, the File Manager screen **500** (FIG. **8**A) by pressing the File Manager button **218**, the Users screen by pressing the Users button **220**, the Data Acq. Screen by pressing the Data Acq. Button **222**, the Harvest Screen **320** by pressing the Harvest Screen button **224**, the Logoff function which allows the operator at the end of the day/shift to clock out by pressing the Logoff button **226**, the Config screen by pressing the Config button **227**, and the Harvest Screen **320** by pressing the Close button **228**.

As shown in FIG. **6**, the Job List screen **230** which is selected by pressing the Job List button **212** from the Settings/Configuration screen **210** has four components, the Job List box **232**, an Open Job button **234**, a New Job button **236** and a Cancel button **238**. Select the tract name or number from the Job List box **232** and press the Open Job button **234** to continue work on a previously created job. Press the New Job button **236** to begin a new job. When assigning a new name for a tract it must begin with a letter. After creating a new file, the operator may then import shape, aerial, and/or LIDAR files from the Importing Shape File screen **501**, the Importing Aerial Photos screen **502**, and the Importing LIDAR Images **503**. Press the Cancel button **238** to return to the main screen **240**.

As shown in FIG. **7**A, the main screen **240** has eighteen components, the Harvest screen **276**, the Console button **242**, the Notes button **244**, the Path Select button **246**, the Show Boundary button **248**, the Show Aerial button **250**, the Start A button **252**, the Start Road button **254**, the GPS STATUS button **256**, the AREA INFORMATION button **258**, the DIST. INFORMATION button **260**, the PRODUCT INFORMATION button **262**, the Exit button **264**, the Zoom Extents button **266**, the Pan Map button **268**, the Zoom Out button **270**, the Zoom In button **272**, and the STATUS INDICATORS **274**. Options and controls are selected by simply touching the desired button on the screen.

As shown in FIG. **7**B, the Harvest screen shot **278** shows three previous path directions with current harvest path.

As shown in FIG. **7**E, the Harvest screen shot **284** shows tract with tract shape file toggled on and aerial photograph toggled off.

As shown in FIG. **7**F, the Harvest screen shot **286** shows the area highlighted to determine area.

As shown in FIG. **7**G, the Harvest screen shot **288** the red line is distance between two points (1,686 ft/0.32 mi.).

As shown in FIG. **8**A, the File Manager screen **500**, which is selected by pressing File Manager button **218** from the Settings/Configuration screen **210** has twelve components, an import/export file source selection box **510**, a left-hand file box **512**, a Move right button **518**, a Copy right button **516**, a Move left button **520**, a Copy left button **522**, a right-hand file box **514**, a Shapefile button **524**, a Aerial button **526**, a LIDAR button **528**, an Export button **530**, and a Close button **532**. The File Manager screen **500** provides several means of file management. A previously created *.gtg file which is the complete harvest file for the system. Conversely the *.gtg harvest files can be copied/moved to a jump drive for post processing. New jobs can be created on the Timber Guide system and then import individual Shape files, Aerial files (*.sid), and/or LIDAR/elevation files (*.dem). The file manager also allows the operator to export **530** relatively small shape files from the system for easy data transfer. The export option may be used for data transfer if aerial and/or LIDAR images are being utilized in the *.gtg harvest file. In order to import shape, aerial, and/or LIDAR files, they need to be in individual sub-directories on the jump drive labeled as follows in the following format: shapefiles—standard format (6 files), aerials−*.sid+utm datum, LIDARS−*.dem+utm datum. To import a file, insert a USB jump drive into the USB port, select jump drive source from the import/export file source selection box **510**, select desired destination file from the left-hand file box **512**, press Copy left button **522** or Move left button **520** to place file in the Job Folder on computer. To export a file, insert a USB jump drive into the USB port, select jump drive source from the import/export file source selection box **510**, select desired file from the left-hand file box **512**, and press Copy right button **516** or Move right button **518** to place the file on the jump drive. Press the Close button **532** to return to the main screen **240**.

As shown in FIG. **8**B, to import a shape file press the Shapefile button **524** on the File Manager screen **500**. Select the drive containing the shape file from file source selection box **536**, select the desired shape file (*.shp) from right-hand file box **538**, select the desired job file (*.gtg) from the left-hand file box **534**, and then press the Import button **542**. Press the Close button **540** to return the File Manager screen **500**.

As shown in FIG. **8**C, to import an aerial photo file press the Aerial button **526** on the File Manager screen **500**. Select the drive containing the aerial photo file from file source selection box **546**, select the desired shape file (*.sid) from right-hand file box **548**, select the desired job file (*.gtg) from the left-hand file box **544**, and then press the Import button **552**. Up to four aerial photo files can be incorporated per job. Press the Close button **550** to return the File Manager screen **500**.

Refer to FIG. **8***d*, to import a LIDAR image file press the LIDAR button **528** on the File Manager screen **500**. Select the drive containing the LIDAR image file from file source selection box **556**, select the desired LIDAR image file (*.dem) from right-hand file box **558**, select the desired job file (*.gtg) from the left-hand file box **554**, and then press the Import button **562**. Up to four LIDAR image files can be incorporated per job. Press the Close button **560** to return the File Manager screen **500**.

Refer to FIG. **8***e*, to export stored data layers as a compressed database file (*.gtg) press the Export Button - - - on the File Manager Screen **500**. Select the desired job file (*.gtg) from the left-hand file box - - - , select the desired destination drive - - - , and then press the Export button. Press the Close button - - - to return to the File Manager Screen **500**.

As shown in FIG. **9**, the Harvest Configuration screen **320**, which is selected by pressing the Harvest button **224** from the Settings/Configuration screen **210** has nine components, a Thinning button **324**, a Final button **322**, a Spacing button **326**, a Width button **328**, a Initial button **330**, a Target button **332**, an Offset button **324**, an OK button **338**, and a Cancel button **336**. The Harvest Configuration screen **320** allows you to choose a thinning operation or final harvest. Pressing the Thinning button **324** gives setup guidance for spacing of corridor/down row centers by tapping Spacing button **326**, width of corridor/down row by tapping Width button **328**, initial stand density (theoretical tress/acre) by tapping Initial button **330**, target stand density (desired trees/acre) by tapping Target button **332**, shear offset tells computer the distance the saw head is in front of the GPS antenna by tapping Offset button **324**. Pressing the Final button **322** tells the

computer to perform a final harvest and removes thinning parameters. Press the OK button **338** to confirm setup and return to the main screen **240**.

Pressing the Console button **242** will bring up the Operator Settings/Configuration Screen **210**, as shown in FIG. **5**B.

Pressing the Notes button **244** located on the main screen **240** brings up the Notes Interface page **350**. The Notes Interface allows the user to mark and enter observations or areas of concern or interest during harvest, and create frequently used "marker" names, for example, Well Location, Deer Camp, Trash Pile, Gully, etc.,. Refer to FIG. **10**, the Notes Interface page **350** has seven components, a Label box **352** which allows the operator to mark point(s)-of-interest (POI) locations by pressing the Custom button **354** to access the on-screen keyboard, a Default Notes box **356** for frequently used notations, a New button **358** to create frequently used notations, a Log Set button **360** which is a custom marker (rectangle with flag) to mark set location.

Pressing the Path Select button **246** located on the main screen **240** displays current and previously created guidance paths. This function allows the user to change from the current guidance path to any guidance paths previously created by tapping the desired path. Referring to FIG. **7***b*, the Harvest screen shot **278** shows three previous path directions along with current harvest path.

Pressing the Show Boundary button **248** located on the main screen **240** displays current boundary of tract shape. Referring to FIG. **7***c* and **7***d*, the Harvest screen shot **280** shows tract shape file toggled on/off.

Pressing the Show Aerial button **250** located on the main screen **240** displays current boundary of photograph. Referring to FIG. **7***e*, the Harvest screen shot **284** shows tract with tract shape file toggled on and aerial photograph toggled off.

The Start A button **252** located on the main screen **240** creates an A-B line. After selecting, button changes to green, upon turning green, either close the accumulator/gather arm or tap a point on the screen to mark start point A. The Start A button **252** changes to End B. After reaching the end of current path, select the End B button to mark the end point of A-B line by using the accumulator/gather arm or tap desired endpoint on screen after button turns green.

Pressing the Start Road button **254** located on the main screen **240** will allow the operator to map highways, gravel roads, or wood trails while driving down them or while creating new roads or paths. After selecting the Start Road button **254**, the button changes to End Road. The user will select Start Road to start mapping and select End Road to quit mapping.

Pressing the GPS STATUS button **256** located on the main screen **240** brings up the GPS STATUS page **370** providing GPS position data. The GPS STATUS page **370** initiates the computer to start receiving and collecting data from the GPS receiver. Refer to FIG. **11**, the GPS STATUS page **370** has seven components, a Direction box **372** when moving in a consistent direction will give you a compass bearing (0-359°), a Speed box **374** which indicates ground speed in mph, a Longitude box **376** which indicates location east to west, a Latitude box **378** which indicates location north to south, a Satellites box **380** which indicates the number of satellites detected, PDOP—Precise Dissolution of Precision box **382** which indicates the quality of satellite data, and a Start button **384** which must be pressed for the computer to start receiving and collecting data from the GPS receiver. The Start button **384** will change to stop after being selected. Pressing the Stop button will stop GPS data collection.

Pressing the AREA INFORMATION button **258** located on the main screen **240** allows the operator to select points on the screen (bar turns green) to create a polygon shape with straight edges (no curves) on the screen to determine acres. Acres will be displayed in area information bar. Select bar again to turn off. Refer to FIG. **7***f*, the Harvest screen shot **286** shows area highlighted to determine area.

Pressing the DIST. INFORMATION button **260** located on the main screen **240** will aid in laying out log sets and skid lengths. Upon selecting the DIST. INFORMATION button **260** turns green. Tap beginning and endpoints on screen. A red line will mark measured distance. Pressing the DIST. INFORMATION button **260** will provide distance in feet and miles. Referring to FIG. **7***g*, the Harvest screen shot **288** shows red line is distance between two points (1,686 ft/0.32 mi.).

Pressing the PRODUCTION INFORMATION button **262** located on the main screen **240** brings up the PRODUCTION INFORMATION page **390** allowing the operator to view productivity data. Referring to FIG. **12**, the PRODUCTION INFORMATION page **390** has six components, a Runtime box **392** which indicates a running total of machine hours spent harvesting, a Avg. Speed (mph) box **394** which indicates average travel speed, a Trees/hr box **396** which indicates a running calculation of average trees harvested per hour, a Acres/hr box **398** which indicates a running calculation of acres harvested per hour, a Target Density box **400** which indicates the desired final stand density (entered in the Harvest screen **320**), and a Current Density box **402** which indicates a running calculation based on number of trees currently removed from a given area versus the initial theoretical stand per acre. Of course, other types of calculations may be used which are indicative of production.

Pressing the Zoom In button **272** located on the main screen **240** allows the operator to incrementally increase the magnification of the current map view.

Pressing the Zoom Out button **270** located on the main screen **240** allows the operator to incrementally decrease the magnification of the current map view.

Pressing the Pan Map button **268** located on the main screen **240** allows the operator to select a point on the map and drag the map to view different areas.

Pressing the Zoom Extents button **266** located on the main screen **240** allows the operator to zoom out to view the entire map or shape file.

Pressing the EXIT button **264** located on the main screen **240** closes the Harvest screen **276**.

The main screen **240** has four Status Indicator lights **274** located in the upper right-hand of the screen. The first indicator light on the left changes from red to green when the computer is communicating with the GPS receiver. The second indicator light changes from red to green when the computer is collecting data. The third indicator light changes from red to green when the accumulator/gather finger is closed (tree has been harvested). The fourth indicator light changes from red to green when the bundle of trees is laid down. The third and fourth status indicator lights may be indicative other functions performed by other pieces of equipment on which the system may be installed.

As shown in FIG. **13**, the monitor **410** has six interface buttons and an indicator LED. The D button **412** is a dimmer toggle with low, medium and high settings. The A (UP) button **414** is the up arrow which increases menu settings. The V (DOWN) button **416** is the down arrow which decreases menu settings. The S button **418** is used to toggle sources between computer, AV**1** and AV**2**. The M button **420** is for menu options. The screen status indicator **422** is red when the screen is off and green when the screen is on. The screen power button **424** toggles the monitor on and off.

Forest harvesting equipment control interconnects **450**, refer to FIG. **14**. The GPS antenna **452** coaxially coupled to GPS receiver **454**. The GPS receiver **454** communicates with computer **460** serially via DB**9** connector. The computer **460** communicates with the LCD touch panel **456** graphics port the via DB**15** connector. Also, the computer **460** communicates with LCD touch panel **456** serially via the USB port connector. The computer communicates with the data acquisition device **458** serially via the USB connector. A 12V DC battery **464** is connected to all devices in the normal manner to one skilled in the art. In the case of 24V DC systems a 24V to 12V power inverter is incorporated into the system.

Thus, the present invention provides a GIS application available to the operator which can be used for a number of purposes. The onboard operator and equipment interface allows an operator access to all available property parcel GIS information. This allows for real-time documentation and mapping of forest management events and activities. Examples of features may include, on screen creation of polygons for area determination, distance measurement tools, remote sensing imagery, general topographical map overlays, guidance tools for standardizing travel path directions and spacing, equipment activity mapping points with associated time, date, and location information. Examples of such mapping points may include: harvested trees; laid down bundles of trees; trees per bundle laid down; retrieved bundles of trees with associated tree count; loaded forestry products; delivered forest products; creek (SMZ) crossing points; road system construction and utilization; use frequency in equipment traffic zones; snow grooming areas and activities; fire line construction and maintenance; gas pipeline or utility construction areas; mapping of discovered invasive or exotic plant areas; mapping of discovered endangered plant and animal species; extrapolated areas of excessive wheel slip, rutting or environmental disturbance; corrective best management practices (BMP's); construction of water bars; road or log set maintenance; and SMZ crossing maintenance. Of course numerous other types of mapping points may be recorded which are associated with machine operations or observations of an operator of a machine.

Thus, the present invention allows for reduction in timber company and contractor labor cost by utilizing stand mapping, boundary marking, pre-harvest and reforestation orientation, documentation time, logging and application supervision, and liability cost of labor. The invention will also minimize timber production input costs while maximizing operations equipment value by minimizing product waste, reducing tillage procedures, and VRT (Variable Rate Technology) for fertilization and vegetation management. Another aspect of the present invention relates to an increase in forest productivity by using true documentation of harvest acres and yield, optimizing stand density with harvest mapping systems, and VRT (Variable Rate Technology) use in applying fertilizer and herbicides. An increase in silvicultural equipment productivity by using shape file maps for mid-rotation procedures, integrating topographical mapping to maximize contour tillage, using VRT (Variable Rate Technology) information generated from harvest equipment, and integrating emerging LIDAR information. Also an increase of production for harvest equipment by using GIS boundary delineations, GPS terrain and environmental hazards, yield mapping, and coordination of harvesting equipment, for example, tree harvest, log skidding, and hauling.

Another aspect of the present invention relates to providing greater environmental protection by creating an accurate delineation of SMZ's (Streamside Management Zones) and ephemerals. Using alerts for excess slippage/rutting. Accurate documentation of SMZ (Streamside Management Zone) crossings throughout the harvesting tract. Utilizing topographical maps, LIDAR imaging, and GPS to minimize environmental impacts.

Another aspect of the present invention is logistics monitoring (log Set to Mill). GPS determined routing is given to truck at dispatch point or via cellular link. Data log of routes, speed and time stopped. An electronic tag given to load at log set which includes location, owner, job number, and time and date stamp. Real-time harvest updates.

Another aspect of the present invention is harvest monitoring. A machine sensor operatively connected to shear equipment may be used to collect tonnage data on the go which includes productivity information and yield data for VRT (Variable Rate Technology) fertilization prescriptions. A slippage monitor may be used whereby the ground speed from driveline sensor is compared to GPS ground speed to develop percentage slip information which will provide some correlation to rutting.

Another aspect of the present invention is topographical based thinning optimization patterns. This is accomplished by developing topographical maps based on LIDAR imaging, and also developing optimized harvest patterns from topographical data.

One of the advantages the present invention is providing a simplified interface to a powerful GIS application. The simplified interface is suitable for use by an operator of a machine conducting operations on a land base, such as through the use of a touch screen display. Yet, the underlying GIS application is powerful enough and flexible enough to perform functions associated with a GIS application. Thus, an operator can see numerous data layers associated with the land base and available information.

IV. Reporting

The present invention further provides for reporting which may occur during or after field work associated with the land base. The reporting may be used for numerous purposes, including documentation, planning purposes, compliance purposes, valuation of a land base, evaluation of productivity of workers or equipment as well as numerous other purposes related to direct interaction of equipment and people with land and natural resources.

According to another aspect of the present invention, the data collected with operations such as timber harvesting may be evaluated to determine the productivity of loggers or others who perform harvesting operations. The present invention contemplates any number of types of reports. Examples of productivity reports include daily, weekly, and whole-tract productivity reports. A daily productivity report may show a map of the land base and associated data points for particular types of operations. The daily productivity report may include production time as a percent of each hour spent actually harvesting. Maximum, minimum, and averages may be given for the day. Another measure of daily productivity may be number of trees harvested each hour. Maximum, minimum and average values may be given. Yet another measure of daily productivity may be the number of trees harvested per hour. Maximum, minimum, and average values may be given. In addition, the number of acres harvested may be given as well as other information which is indicative of productivity. Data may be presented in any number of formats, including as tables, bar graphs, line graphs, or other formats.

A daily, weekly, monthly, quarterly or other type of time-period based productivity report may include a map of the land base and associated data points for particular types of operations. The weekly productivity report may include production time as a percent of each hour spent actually harvest-

ing. Maximum, minimum, and averages may be given for the day. Another measure of weekly productivity may be number of trees harvested each hour. Maximum, minimum and average values may be given. Yet another measure of weekly productivity may be the number of trees harvested per hour. Maximum, minimum, and average values may be given. In addition, the number of acres harvested may be given as well as other information which is indicative of productivity. Data may be presented in any number of formats, including as tables, bar graphs, line graphs, or other formats.

A tract productivity report may include a map of the land base and associated data points for particular types of operations. The tract productivity report may include production time as a percent of each hour spent actually harvesting. Maximum, minimum, and averages may be given for the day. Another measure of tract productivity may be number of trees harvested each hour. Maximum, minimum and average values may be given. Yet another measure of tract productivity may be the number of trees harvested per day. Maximum, minimum, and average values may be given. In addition, the number of acres harvested may be given as well as other information which is indicative of productivity. Data may be presented in any number of formats, including as tables, bar graphs, line graphs, pie charts, or other formats. Maps may accompany the data to provide additional context for the data.

Thus, reporting may provide for determining the operating efficiency of equipment with regards to the performance of the exact task for which said equipment was designed vs. actual total time of operation over any pre- or post-determined period of time. For example the reporting may include tree retrieval equipment time spent retrieving vs. total time operating or specific task operation of equipment vs. total operating time of equipment.

In addition to productivity reports, the present invention contemplates that other types of reports may be prepared based on the information

V. Fire Suppression on a Land Base

Another embodiment of the present invention relates to fire suppression and management of fires on a land base. Machines associated with fire fighting may be equipped with the GIS application to collect, send, and receive information related to a fire and the land on which the fire is located. This may include information regarding timber on the land base, stream management zones, roads, and other boundaries. This information may also include the location of individuals, other pieces of equipment, or the location of other resources used to fight or suppress the fire, or the location and/or movement of the fire itself. The invention may also aid in the suppression and planning of fire fighting activities by providing real-time information concerning the fire and real-time location of personnel and equipment to other personnel, equipment, or centralized dispatching location. Having appropriate information at the location and time of need is advantageous for a number of reasons, including efficiency, effectiveness, and safety. Where the present invention is used in fire suppression activities, the GIS application is configured to include layers associated with fire suppression. The GIS applications may be run on computers operatively connected to various types of machines associated with fire suppression activities or which support fire suppression activities. Examples of machines which may be used in fire suppression activities include, but are not limited to, bull dozers, fire plows, ATV'S, tractors, water vehicles, and/or other suppression equipment. Examples of sensors used may include contact or position sensors associated with a bull-dozer blade, fire plow, or flowmeters attached to a water truck or other piece of equipment used to deliver chemical or liquid fire suppression substance. The invention will dramatically increase the safety of individual personnel through the use of personal locator tags/beacons/transmitters whether with or without GPS enablement. This increased level of safety will come by providing real-time data concerning the location and direction of travel of individual firefighters or crews, by transmitting said information to and through other pieces of equipment on which the invention is installed to the centralized dispatching location.

VI. Utility/Right-of-Way Management

Another application of the present invention relates to utility management. Utilities such as, but not limited to gas lines, power lines, and water lines have problems in terms of collecting and documenting information concerning the type and extent of invasive species encroachment as well as mechanical operations for vegetation and soil erosion management. Utility management has many problems similar to those experienced in forestry management from the standpoint of collecting accurate information and documenting operations performed on utility right-of-ways. Where used for utility management, the GIS application may be configured with data layers for use in support of utility management activities.

Examples of machines associated with utility management include machines for brush cutting, mulching, machines associated with station management, mowers, machines associated with tree trimming, bull dozers, tractors, ATVs, marsh buggies, and other types of machines. Examples of types of sensors include sensors for determining when a cutting operation is performed, sensors for determining when a dirt moving operation is performed, or other type of sensors.

VII. Slope and Snow Management

Another application of the present invention relates to slope and snow management such as may be performed by a ski resort or ski recreational area. In slope and snow management, considerable efforts are expended grooming ski slopes, making "snow", construction, maintenance, and design of snow and/or terrain parks, identifying and protecting skiers from hazards, and related activities. The management of the slopes, another type of land base, may benefit from the present invention where the GIS application is configured for slope and snow management with appropriate data layers. Examples of types of machines include snow cats with grooming attachments, blades, or snow blowers. Examples of sensors used may include contact or position sensors associated with snow cat blade or blower. Sensors may be used to detect when moving snow, or changing terrain. People on the ground may include mountain or trail maintenance personnel, ski patrol or emergency patrol, or others. The invention may dramatically increase the safety of individual personnel through the use of personal locator tags/beacons/transmitters whether with or without GPS enablement. This increased level of safety will come by providing real-time data concerning the location and direction of travel of individuals working in ski areas, by transmitting said information to and through other pieces of equipment on which the invention is installed to the centralized dispatching location.

The present invention may be used for management of a land base for any number of purposes. A preferred embodiment has been described with respect to performing timber or forestry related applications. However, there are numerous other examples of land management activities with which the present invention may be used. These include land management activities associated with agricultural, land management activities associated with environmental monitoring or management, land management activities associated with

fires suppression, land management activities associated with managing land for use as a ski area or other type of recreational uses.

What is claimed is:

1. A method for management of a land base wherein operations are performed on the land base by an operator operating equipment, the method comprising:

interfacing the equipment to a computer running a geographical information system (GIS) application such that the computer is configured to monitor each occurrence of the operations using one or more machine sensors and store the operations as map points on at least one data layer within the GIS application; and

displaying the GIS application and the operations as the map points to the operator at a location and time of performing the operations to assist the operator in operating the equipment by recording specific actions taken by the operator as detected by the one or more machine sensors;

wherein the operations are mechanical operations individually and deliberately performed on the land base by the operator through manual control of the equipment;

wherein the one or more machine sensors are positioned on the equipment to detect occurrence of the mechanical operations as the operator manually controls the equipment to perform the mechanical operations.

2. The method of claim **1** wherein the step of displaying the GIS application comprises displaying the GIS application to the operator on a touch screen display, the GIS application having a user interface adapted for control by the operator using the touch screen display.

3. The method of claim **1** further comprising recording the GIS application.

4. The method of claim **3** further comprising recording the operations performed in a report.

5. The method of claim **2** further comprising analyzing data in the at least one data layer and outputting a report.

6. The method of claim **5** wherein the report is from a set consisting of a productivity report, a statistical report for the land base, and an environmental report.

7. The method of claim **1** wherein the operations are timber harvesting operations and wherein the equipment comprises equipment used in timber harvesting operations.

8. The method of claim **1** wherein the map is a topographical map.

9. The method of claim **1** further comprising communicating data describing the operations to one or more additional pieces of equipment.

10. The method of claim **1** wherein the GIS application further comprises at least one data layer consisting of location of workers, location of machines, a tract shape file, an aerial image, a LIDAR topography, corridor guidance lines, trees harvested, timber bundles laid down, timber bundles picked up, road mapping, tonnage yield monitoring, environmental impact data, stream management zone data, endangered species data, invasive species data, environmental hazard data, wheel slippage data, sustainable forestry initiative data, or combinations thereof.

11. A system for management of a land base, comprising:

a self-propelled machine for performing land management operations on the land base;

a computer operatively connected to the self-propelled machine;

a GIS application executing on the computer;

a geoposition determining device in operative communication with the computer;

at least one machine sensor operatively connected to the self-propelled machine and in operative communication with the computer for sensing the land management operations performed by an operator operating the self-propelled machine on the land base;

wherein the GIS application being adapted to display a map and a plurality of layers of data on the map;

wherein at least one of the plurality of layers of data comprises data indicative of the land management operations performed by the operator operating the self-propelled machine on the land base;

wherein the land management operations are mechanical operations individually and deliberately performed on the land base by the operator through manual control of the self-propelled machine;

wherein the at least one machine sensors are positioned on the self-propelled machine to detect occurrence of the mechanical operations as the operator manually controls the self-propelled machine to perform the mechanical operations.

12. The system of claim **11** wherein the land management operations comprise timber management operations.

13. The system of claim **12** wherein the self-propelled machine being from a set consisting of a feller buncher, a skidder, a loader, a harvester, a swing machine, a forwarder, and/or a bulldozer.

14. The system of claim **11** further comprising a wireless transceiver operatively connected to the computer and adapted for sending and receiving data with one or more additional machines.

15. The system of claim **11** wherein the GIS application being adapted to perform at least one of an area calculation operation, a distance calculation operation, a road mapping operation, and a yield monitoring operation.

16. The system of claim **11** further comprising at least one additional sensor for sensing wheel slippage associated with the self-propelled machine.

17. The system of claim **16** wherein the GIS application adapted for displaying wheel slippage on the map.

18. The system of claim **11** wherein the GIS application further comprises at least one data layer consisting of location of workers, location of machines, a tract shape file, an aerial image, a LIDAR topography, corridor guidance lines, trees harvested, timber bundles laid down, timber bundles picked up, road mapping, tonnage yield monitoring, environmental impact data, stream management zone data, endangered species data, invasive species data, environmental hazard data, wheel slippage data, sustainable forestry initiative data, or combinations thereof.

19. The system of claim **11** further comprising a bus module operatively connected between the computer and the self-propelled machine for accessing data about operation of the machine.

20. The system of claim **11** wherein at least one of the plurality of layers of data comprises data indicative of land management operations performed by a second self-propelled machine on the land base.

21. A method for management of a land base wherein work operations are performed on the land base by an operator operating a machine, the method comprising:

interfacing the machine to a computer using a bus module electrically connected to the machine and the computer;

placing a geographical information system (GIS) application on the computer such that the computer is configured to monitor the operations and store location and

data about the operations as map points, lines, or polygons on at least one data layer within the GIS application;

displaying the GIS application and the at least one layer to the operator on a touch screen display at a location and time of performing the operations to assist the operator in operating the machine by recording specific actions taken by the operator as detected by one or more machine sensors;

wherein the GIS application comprises a plurality of data layers, including at least one data layer comprising data for work operations performed by a second machine; and

wherein the work operations are mechanical operations performed on the land base by the operator through manual control of the machine.

22. The method of claim **12** wherein at least one of the plurality of data layers comprises worker location data.

23. A method for management of a land base wherein operations are performed on the land base by equipment operated by an operator, the method comprising:

interfacing the equipment to a computer running a geographical information system (GIS) application such that the computer is configured to monitor the operations and store the operations as map points on at least one data layer within the GIS application; and

displaying location information and the at least one data layer containing the operations as the map points within the GIS application on a display and to the operator at a location and time of performing the operations to assist the operator in operating the equipment by recording specific actions taken by the operator as detected by one or more machine sensors;

wherein the operations are mechanical operations individually and deliberately performed on the land base by the operator through manual control of the equipment.

24. A system for management of a land base, comprising:

a computing device;

a touchscreen display operatively connected to the computing device;

a geoposition determining device in operative communication with the computer;

a GIS application executing on the computing device;

wherein the GIS application provides for displaying a map showing a current location determined by the geoposition determining device and a plurality of layers of data on the map;

wherein the GIS application provides for onscreen creation of polygons by a user for area determination using the touchscreen display to assist the user in performing work operations on the land base;

wherein the GIS application provides an onscreen distance measurement tool to assist the user in performing work operations on the land base by calculating distance between two points selected by the user through the touchscreen display;

wherein the GIS application provides at least one of skidder data, feller buncher data, and loader data to the user; and

wherein the at least one of skidder data, feller buncher data, and loader data shows the user the real time land base operations of a separate user located in a skidder, feller, or loader.

25. The system of claim **24** wherein the plurality of layers include:

(a) a skidder data layer for the skidder data;

(b) a feller buncher data layer for the feller buncher data; and

(c) a loader data layer for the loader data.

26. The system of claim **24** further comprising a wireless transceiver operatively connected to the computing device and wherein the computing device is configured to receive data from forestry equipment and display the data on the map of the GIS application.

27. The system of claim **24** further comprising a plurality of machine sensors operatively connected to the computing device for collecting data indicative of work operations performed on the land base and wherein the GIS application provides for generating map points indicative of the work operations.

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